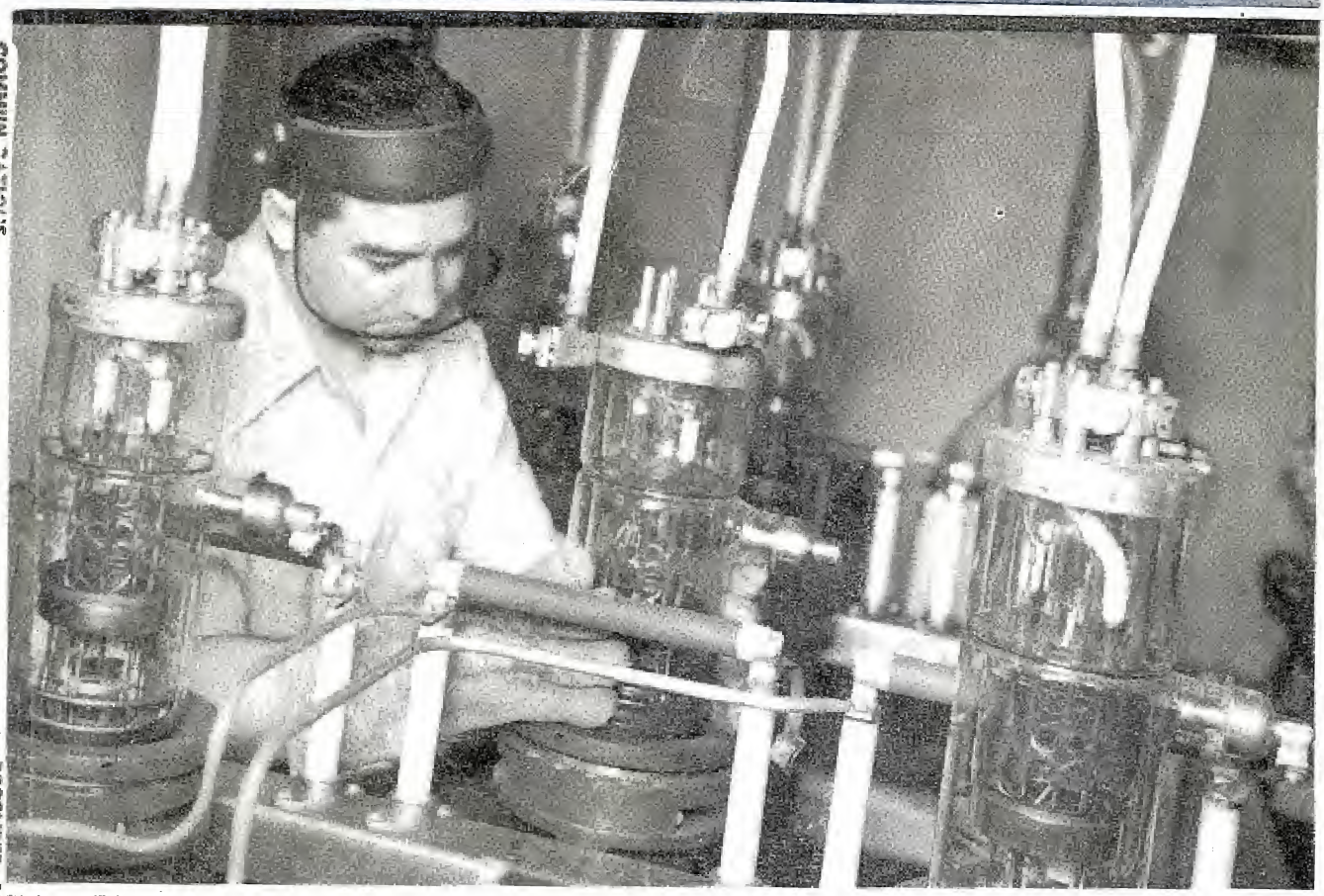
VOL. 24, NO. 12

COMMUNICATIONS



COMMUNICATIONS

DECEMBER, 1944

DECEMBER

- ★ RADIO ENGINEERING
- ★ REPORT ON IRE FALL MEETING
- ★ TRANSMISSION LINE DIELECTRICS
- ★ AERONAUTICAL COMMUNICATIONS
- ★ H-F HIGH-POWER TRANSMITTER DESIGN
- ★ TELEVISION ENGINEERING

1944

HYTRON has made them all!

The march of Hytron receiving tube progress down through the years is fascinating. One looks back on tubes, tubes, and more tubes: battery, AC, AC/DC, diodes, triodes, pentodes, beam tetrodes, multiple purpose types, G's, MG's, BANTAM GT's — and now the miniatures. Price and size have been drastically cut; quality and performance, amazingly improved.

Hytron has made them all. Its long and varied experience is priceless in a complex industry where probably never will all the answers be known. In making radio tubes, painfully acquired practical experience must supplement the formulae of science.

With an eye to present and future, Hytron is concentrating its production of receiving tubes on preferred BANTAM GT types needed for war — for today's civilian replacements — and ultimately for post-war. Its wartime activities are teaching Hytron new techniques of miniature production. Many potentially popular Hytron miniatures are in development. Typical American dissatisfaction with anything but perfection continues; the parade of Hytron receiving tubes marches on.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

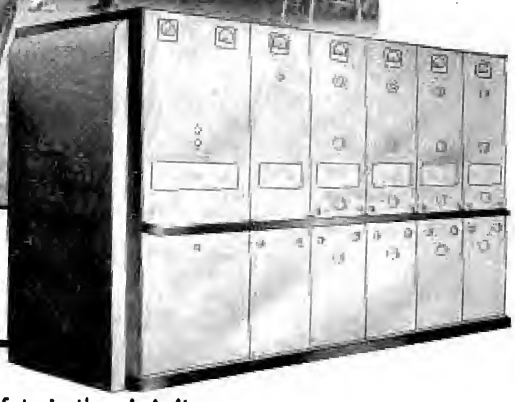
HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

ARMY-NAVY

BUY ANOTHER WAR BOND

AIRPORT LOUNGE at the TACA HEADQUARTERS at TEGUCIGALPA HONDURAS



Comfort at the Airport...

SAFETY IN THE AIR

One of RADIO RECEPTOR'S most valuable contributions to safety in the air is its

3 KW MULTIPLE UNIT GROUND STATION TRANSMITTER

This equipment, Type CT-3000—"THE GLOBE GIRDLER," is used at airports for communication with planes and with other airports—for long distance as well as local communication. It is ruggedly designed for continuous use under adverse and rigorous conditions. Transformer and coils are impregnated for operation in a tropical climate.

OPERATING CHARACTERISTICS

The transmitter assembly is composed of individual units, one for each RF channel, one for each modulator, and one for the rectifier power supply unit. The RF and modulator units are interwired and connected to operate from the common rectifier power supply unit.

FREQUENCY RANGE—2 to 20 mc. RF units are supplied with coils and capacitors to operate at a single specified frequency and output load. Components are available for operation on any other frequency and output load impedance within the limits specified.

POWER OUTPUT—2.5 KW continuous, 3 KW intermittent service.

FREQUENCY CONTROL—Low temperature coefficient crystal control at a sub-multiple of output frequency.

RF LOAD IMPEDANCES—Grounded or balanced transmission line loads—50-700 ohms. Loading inductor or series condenser available on special order for working directly into reactive antenna.

TYPE OF TRANSMISSION—A-1 (CW Unmodulated telegraph), up to four simultaneous channels: or A-3 (telephone Modulated carrier), up to two simultaneous channels.

MODULATION—High level modulation of RF power amplifier by means of Class B audio modulator.

NOISE LEVEL—Carrier noise 40 db. below 100% modulation.

KEYING—High speed (200 words per minute) electronic keying standard. Slow speed keying of oscillator available on special order.

POWER SUPPLY REQUIREMENTS—230 volts 50/60 cycles, 3 phase.

Also available in output powers of 1 and 5 KW. Circular on request.

RADIO RECEPTOR COMPANY, INC.

251 WEST 19th STREET **NEW YORK 11, N.Y.**

SINCE 1922 IN RADIO AND ELECTRONICS

LEWIS WINNER, Editor
F. WALEN, Assistant Editor

We See...

LONG, SWIFT AND DECISIVE were the strides made by *radio communications* during 1944 . . . a year that can be recorded as one of the most significant in *communications* history. While rigid military secrecy precluded a complete discussion of the dominant developments completed, reports from all war theatres gave proof to the salient contributions provided by *communications*. D-Day, June 6, offered strong evidence of that fact . . . with a brilliant test of the worthiness of United States equipment.

And on the home front substantial progress was chronicled too. Hearings that will affect the complete frequency allocation program for the next five to ten years were held by IRAC and the FCC. The importance of *broadcast communications* was stressed by IRAC in alloting 61% of the spectrum between 42 and 1,000 megacycles for f-m, television and relays. At the FCC hearings, experts testified that *radio communications* have become increasingly important to many industries. Aircraft, railroads and emergency services, to cite a few, will demand a variety of equipment. For instance, fire fighting units will probably need equipment for 130.000 units. Over a quarter of a million airplanes will need communications equipment; over 6,000 airports are scheduled for new communications installations. And most of the major railroad lines have made plans for radio communication services. The use of u-h-f and v-h-f for radio and wire relay links was also stressed at the hearings, with A. T. & T. announcing their $2,000,000 coaxial-cable link covering some 7,000 miles, and RCA, G.E. and others disclosing their coast-to-coast satellite station plans.

Yes, 1944 was an epic year in *communications* . . . and 1945 will probably offer lively competition.

THE TWENTY-FIFTH ANNIVERSARY of broadcasting will be celebrated in 1945. Throughout the year broadcast stations will observe this anniversary with appropriate programs. And the featured slogan on all programs will be . . . "Radio's Twenty-Fifth Anniversary . . . Pledged to Victory"!—L. W.

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.
Member of Audit Bureau of Circulations.

DECEMBER, 1944

VOLUME 24 NUMBER 12

COVER ILLUSTRATION

Installing water-cooled power tubes in modulator unit of 200-kw transmitter.
(*Courtesy Federal Telephone & Radio Corp.*)

Published Monthly by the Bryan Davis Publishing Co., Inc.

BRYAN S. DAVIS, President **PAUL S. WEIL, General Manager**
F. WALEN, Secretary **A. GOEBEL, Circulation Manager**

Advertising and Editorial offices, 19 East 47th St., New York 17, N. Y. Telephone PLaza 3-0483. Cleveland 6, Ohio; James C. Munn, 10515 Wilbur Avenue. Pacific Coast Representative: Brand & Brand, 816 W. Fifth St., Los Angeles 13, Calif.; Telephone, Michigan 1732. Wellington, New Zealand: Te Aro Book Depot. Melbourne, Australia: McGill's Agency. Entered as second-class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada; $3.00 in foreign countries. Single copies, twenty-five cents in United States and Canada; thirty-five cents in foreign countries.

. . . and ~~never~~ the twain shall meet

"East is east and west is west," wrote the poet, "and never the twain shall meet."

But he was wrong.

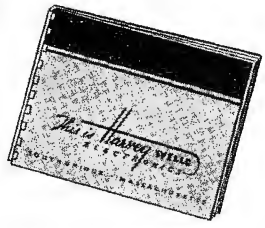
The twain *shall* meet. The peoples of the earth shall begin to know each other — and work together — for peace and plenty for all.

And the miracle will be due in great part to the coming Age of Flight. . . .

Communications will help make Air Transport safer — more economical — faster. Harvey-Wells Electronics produces communications equipment designed for complete dependability, engineered for maximum efficiency . . . selected for War, perfected for Peace.

In the Age of Flight, look to Harvey-Wells for ideas, skill, imagination — setting the pace for progress in communications!

Know the company that wants your business! Our CASE BOOK tells the story of Harvey-Wells and its place in Electronics. Send for it today. Your name on your letterhead is sufficient.



Harvey-WELLS
ELECTRONICS

SETTING THE PACE FOR PROGRESS IN COMMUNICATIONS

HARVEY-WELLS ELECTRONICS, INC. SOUTHBRIDGE, MASSACHUSETTS

PRECISION MADE FOR PRECISE PERFORMANCE *and* PROVED IN USE!

There is no question about AAC crystals meeting the most exacting requirements under severe operating conditions. Their reliability has been tested and proved a thousand times over . . . in battlefront service to the armed forces . . . in helping to keep the communication systems of many leading airlines working efficiently . . . in meeting the quality demands of radio manufacturers. The list of users of AAC crystals shown below is a tribute to the engineering skill and fine manufacturing facilities behind AAC crystals.

Braniff Airways, Inc.
Chicago & Southern Air Lines, Inc.
National Airlines, Inc.
Northwest Airlines, Inc.
Pan American Airways System
Pan American-Grace Airways, Inc.
Pennsylvania-Central Airlines Corp.
Transcontinental & Western Air, Inc.

Colonial Radio Corp.
Columbia Broadcasting System, Inc.
Stewart-Warner Corporation
Western Electric Company, Inc.
Zenith Radio Corporation

Remember, crystal production is only one of AAC's services to the aviation and electronics industries. The production of airborne and ground radio equipment at the rate of more than 30 million dollars yearly for U. S. government and leading airlines demonstrates the wide scope and high rating of AAC manufacturing ability.

E-134

ACCESSORIES CORPORATION

ELECTRONICS • ENGINEERED POWER CONTROLS

New York, N. Y. Burbank, Calif. Cable Address: AACPRO

Would You Pay A WHOLE DOLLAR for your daily paper?

THAT man is here again! The guy who used to say "I can get it for you wholesale" now whispers: "I can get it for you WITHOUT RATION COUPONS . . ." The sad thing is that—he CAN. But, oh, what a price you pay!

You can't beat arithmetic. If there are ten refrigerators for sale and a hundred eager bidders for them, the seller is going to nick those ten buyers for *all the traffic will bear!* Then prices soar . . . the dollars that buy those refrigerators drop in value. Too few goods, too much money on the loose, connive to breed the worst of all national dangers: INFLATION. A 100-cent dollar sinks to 5c—or less—in buying power! Uncontrolled prices . . . *less* for your hard-earned money! A drop in the value of your savings account, of your insurance, of everything you own. Would you like to pay a whole dollar for your daily paper?

"Ration coupons?" Oh, nuts! "Ceiling prices?" "Listen, fella, I can get you what you want—for only a few dollars more . . ." Don't you believe him. He can't, *really!* You may not give up ration coupons THIS time, but you may have to give up MUCH more in the long run. The unhappy spiral of inflation can put every thing you want and need 'way beyond your price-reach! Don't let this happen to *you*—your neighbors, your entire nation. Instead, for a FAIR share at a FAIR price, take the Consumers' Pledge of Fair Play, and LIVE UP TO IT: "I will pay no more than ceiling prices; I will take no rationed goods without giving up ration coupons." DEFEAT the scourge of Inflation!

THE MARK OF EXCELLENCE

Here at Kenyon, we're proud to play our small role on the stage of a BIG war. That's why EVERY Kenyon transformer used by our fighting forces throughout the world reflects only the highest precision craftsmanship. Kenyon workers are doing their share—bringing Victory closer by turning out top quality transformers *uninterruptedly*—and as fast as possible!

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

COMIN' AT YOU!

Buy War Bonds

. . . and some for all!

Here comes aluminum . . . rolling out to meet the highest *record* demand in its history . . . and back to do a bigger and better job in PRESTO RECORDING DISCS!

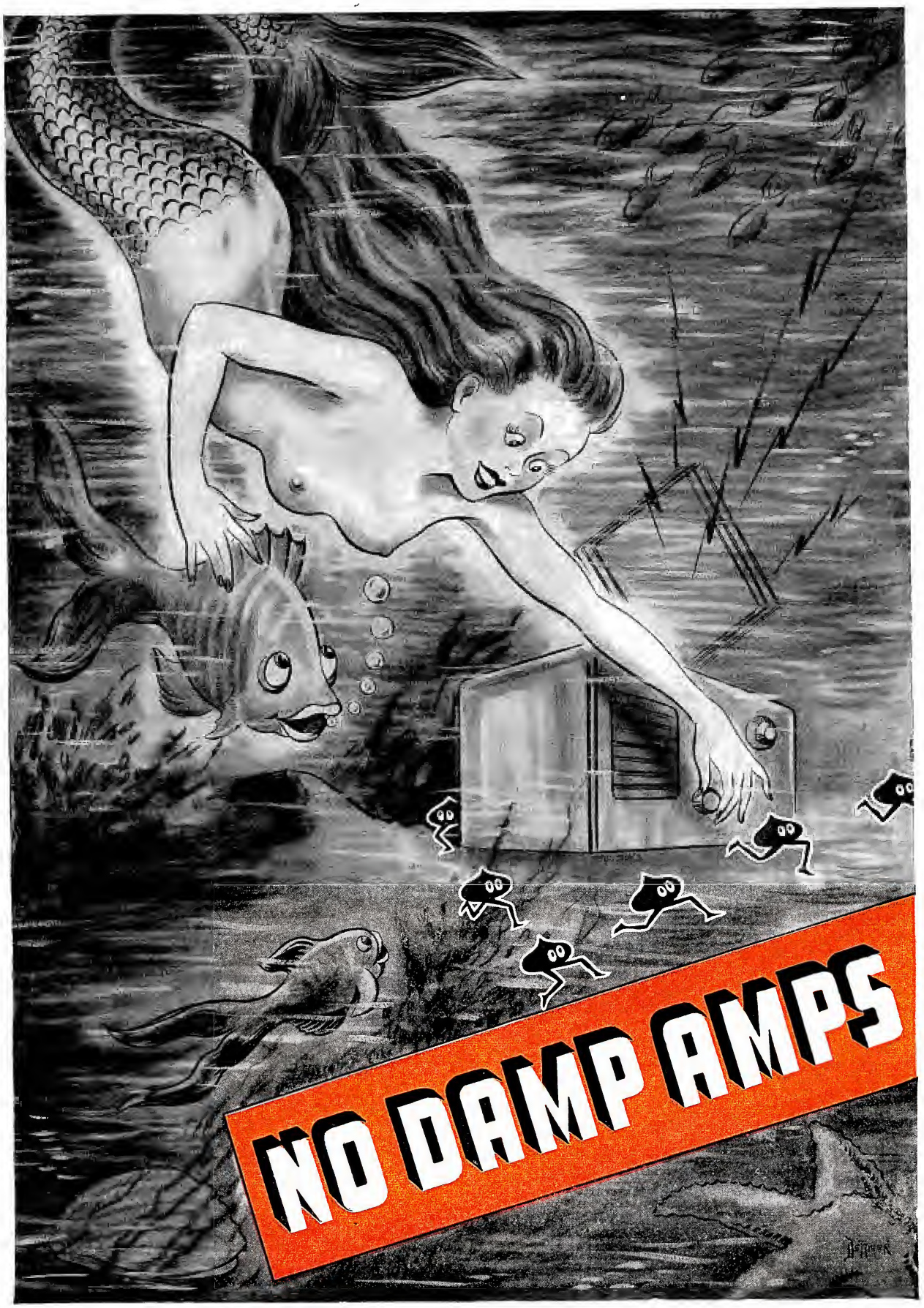
PRESTO *ALUMINUM* RECORDING DISCS are now available in all sizes from 6½ inch to 17¼ inch. That's *good news* for broadcasting stations, recording studios and schools all over the nation . . . who know through valued experience that PRESTO is simpler to handle—doesn't require fussy adjustments . . . and, in fact, is the smoothest cutting disc they've ever used!

Order PRESTO ALUMINUM DISCS from your regular electronics distributor. May we suggest that you split your order—50% aluminum and 50% glass base for the time being, so that we can fairly distribute PRESTO ALUMINUM DISCS over the first big demand?

PRESTO RECORDING CORPORATION

242 West 55th Street **New York 19, N. Y., U. S. A.**

Walter P. Downs Ltd., in Canada


NO DAMP AMPS

New INTERNAL-PIVOT PANEL INSTRUMENTS

2½- inch—1 inch deep

For radio and other communications service: Type DW-51 d-c voltmeters, ammeters, milliammeters, and microammeters; Type DW-52 radio-frequency ammeters (a-c thermocouple-type). Cases are brass or molded Textolite.

A New Design That Puts *More Instrument into Less Space*

These new, internal-pivot instruments were developed to fill a vital need—particularly in the radio and aircraft fields—the need for compactness. They are *thin*—in most ratings, less than 1 inch deep.

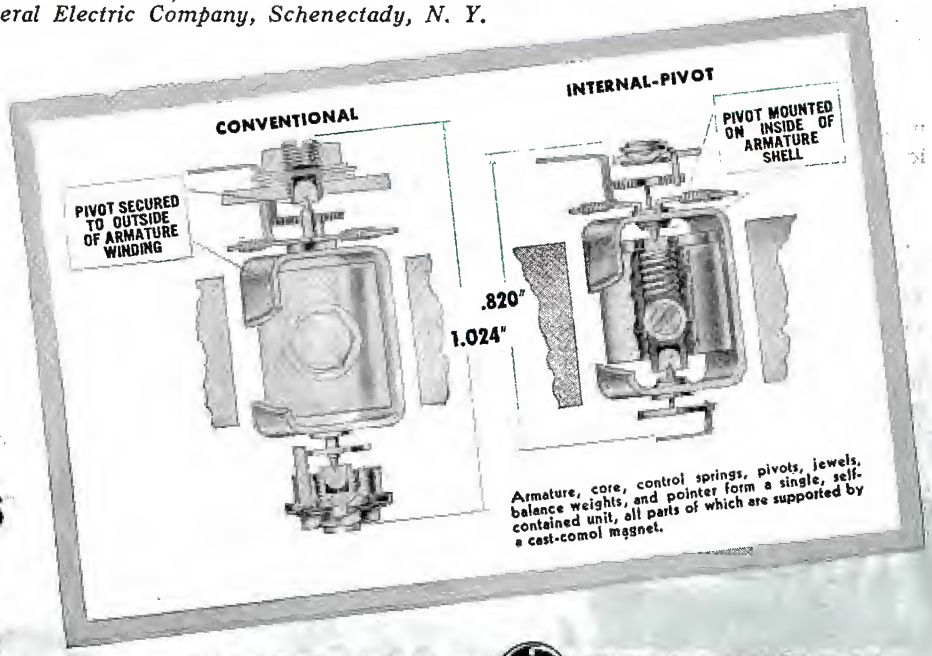
More important is the way their thinness was achieved. In the sketch below, see how the pivots are solidly anchored to the *inside* of the armature shell so they cannot work loose. The moving parts are permanently aligned with stationary parts by bolting the core assembly to a one-piece cast-comol magnet.

Other features are: large-radius pivots, high torque and good damping, lightweight moving element, and ample clearances. Added up, they give you an instrument well able to withstand vibration and hold its rated accuracy, one that is fast on response and easy to read accurately—a design that packs all-round fine performance in a small space.

For ratings, price, and dimensions, ask our nearest office for Bulletin GEA-4064, which covers instruments for radio and other communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Company, Schenectady, N. Y.*

Type DW-53 d-c voltmeters, ammeters, and volt-ammeters that are specially designed to measure voltage and current in battery and battery-charging circuits on naval aircraft. They meet applicable Navy specifications.

Invest in your future
BUY WAR BONDS



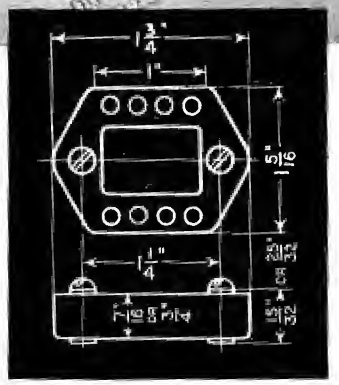
HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

In ratings from 1000 volts to 10,000 volts test . . .

Molded-in-Bakelite

MICA CAPACITORS



● The 1650 Series is the most rugged of the heavy-duty molded-in-bakelite mica capacitors of the extensive Aerovox line. These high-voltage units are intended for the most critical service of low-powered transmitting circuits, buffer stages, power amplifiers, laboratory equipment, etc. Also recommended for use in ultra-high-frequency circuits, and accordingly their r.f. current ratings are given in the Aerovox Capacitor Catalog.

The extra-generous use of high-grade dielectric material provides that greater factor of safety for longer service under severest operating conditions.

Standard units with tapped holes take 6/32 screws which serve for terminals. Also available with clearance holes through which screws or rods may be slipped, so that two or more units can be stack-mounted. Low-loss ceramic mounting insulators are available for mounting on metal surfaces. Standard units molded in brown bakelite. Also available in low-loss (yellow) XM bakelite.

In 1000, 2500, 5000, 7500 and 10,000 volts D.C. test. Capacitance ratings from .00005 mfd. to .06 mfd. in Type 1650 at 1000 v. D.C. test; .00005 mfd. to .001 mfd. in Type 1654L at 10,000 v. D.C. test.

● Literature on request . . .

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. · SALES OFFICES IN ALL PRINCIPAL CITIES

Export: 13 E. 40 St., New York 16, N. Y. · Cable: 'ARLAB' · In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

FROM ONE SMALL TOWN TO THE EARTH'S FAR CORNERS

OUT to the Far East, to ports on the seven seas identified only in code on the packing cases, goes war material so vital that it is needed on every beachhead and before the beachhead is created—poured out of *one* shipping room in just *one* factory in just *one* small Connecticut town!

Incredible? Not when Yankee ingenuity is taken into consideration—the same Yankee ingenuity that stems from many lifetimes of meeting difficult situations.

That's the case here at Ansonia—typical of our approach to the problems which any form of electrical cables can solve. However difficult the requirements of peace may be, we feel that we can be of assistance in meeting them in new ways, as we have met the changing problems of war *and peace* before.

ANKOSEAL multi-conductor insulated cables are among the most promising of Ansonia war-proven developments. If you have, or expect to have, a use for electrical cables—

CHECK ANKOSEAL!

THE ANSONIA ELECTRICAL COMPANY

Specializing in "Ankoseal" a Thermoplastic Insulation

ANSONIA • CONNECTICUT

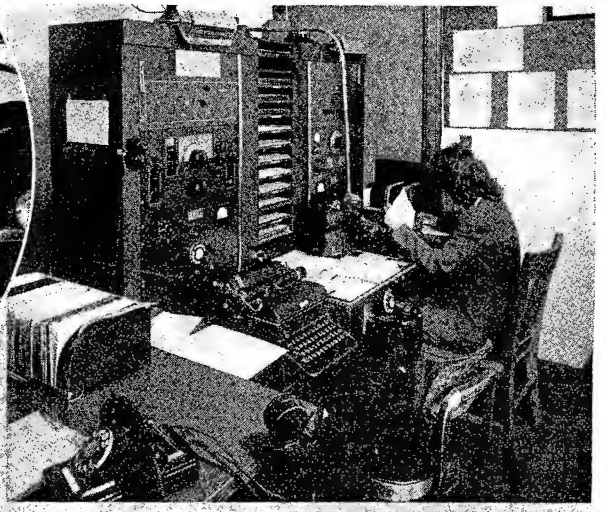
A Wholly-Owned Subsidiary of

NOMA ELECTRIC CORPORATION

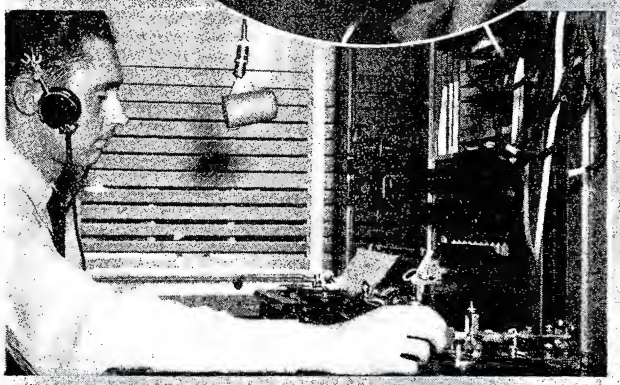
GENERAL OFFICES • NEW YORK, N. Y.

—In peacetime makers of the famous Noma Lights—the greatest name in decorative lighting. Now, manufacturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

EASTERN AIR LINES



MID-CONTINENT AIRLINES

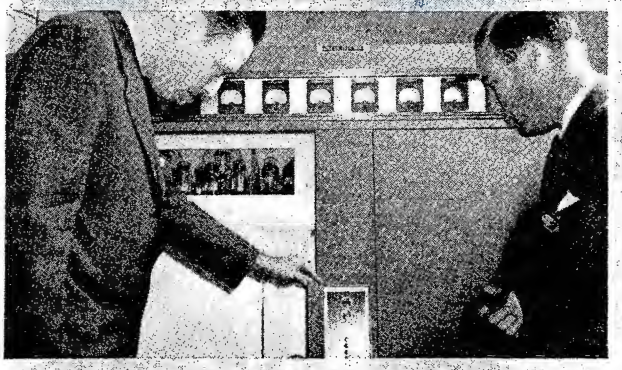


BRANIFF AIRWAYS

Wilcox Installations with the Airlines

for Dependable Radio Communications

For many years the major commercial airlines of the United States have relied upon Wilcox dependability in their daily operations. In the postwar era of electronics and aviation, look to Wilcox for continued leadership in the development of radio communication.



(ABOVE) PENNSYLVANIA-CENTRAL AIRLINES
(BELOW) AMERICAN AIRLINES

WILCOX ELECTRIC COMPANY

Fourteenth and Chestnut Kansas City, Mo.

Manufacturers of Radio Equipment

Variable Tuning Condensers, Push Button Tuning

Mechanisms and Actuators, Phonograph Record Changers

A NEW DIVISION
UNDER THE DIRECTION OF
LEE GOLDER
identified for more than 20 years with the manufacture of radio speakers.

. . . and now speakers by G.I.

Millions of radio components on the far flung battle areas of the world bear the G. I. insignia. What they have accomplished is already in the archives.

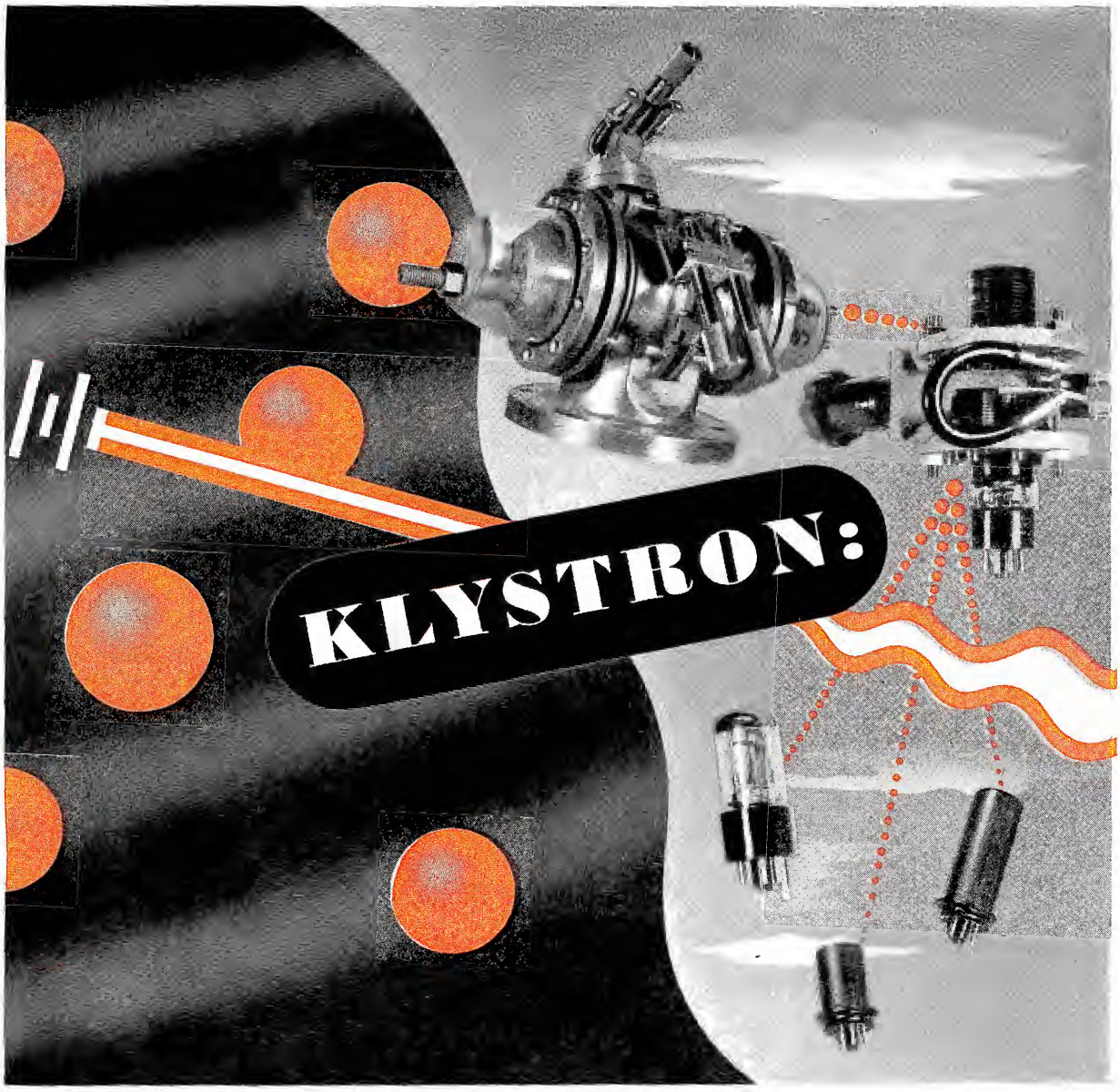
Behind General Instrument's record of achievement in the quantity production of electronic equipment for military use, stands nearly a quarter century of highly specialized production and experience in the field of radio components for home receiving sets.

The addition of a complete line of speakers is, therefore, not a venture into a new field, but the logical outgrowth of our expanded facilities, developed by wartime activities and increased resources in the radio equipment industry.

The resourcefulness and ingenuity—the expanded and perfected facilities that made this mammoth production possible will be put, without stint, behind our new speakers. Set manufacturers will know what this will mean.

GENERAL ELECTRONIC APPARATUS CORP.
A SUBSIDIARY OF
GENERAL INSTRUMENT CORP.
829 NEWARK AVE., ELIZABETH 3, N. J.

The first in our industry to be so honored
ARMY E NAVY



How many Klystrons *are* there?

COMPARED with the early Klystrons which Sperry first developed some years ago, the more recent forms represent dramatic improvements in both size and performance.

And this is only the beginning!

Information on the newer types is presently restricted to those qualified under Military regulations.

But Sperry Klystrons are in use on many battle fronts, and in many applications . . .

There are small Klystrons, and large ones . . . low-powered ones and high-powered ones. There are Klystrons which generate, amplify, and multiply. Where required, frequency stability (better than that required for broadcast purposes) is readily applied by conventional means.

Klystrons are easily modulated for new and all conventional purposes. And, by means of a single knob, they can be tuned continuously over a wide band, or the operator can snap-tune them to previously selected bands.

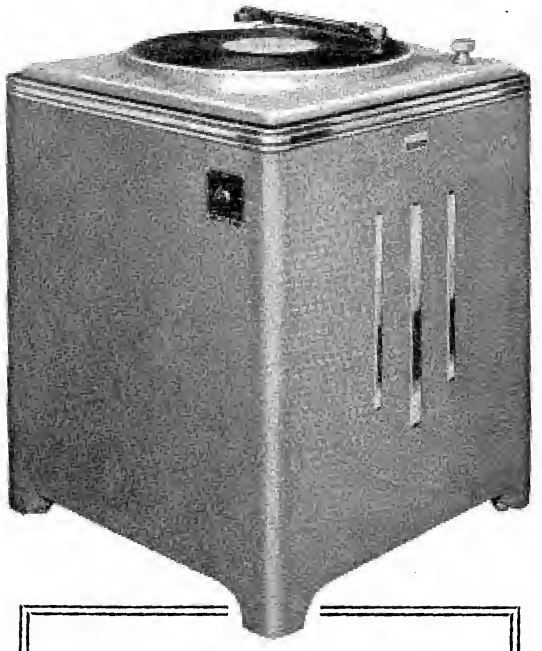
Write us for further information.

Sperry Gyroscope Company INC.

GREAT NECK, N. Y. • DIVISION OF THE SPERRY CORPORATION

GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

Gates Brings You New Turntable Improvements that assure Noiseless Positive Operation



THE GATES CB-7 Transcription Turntable

Engineered for Exceptional Performance
Designed for those who Demand the Best

Developed after months of experimentation with various synthetic rubbers that are impervious to oil and temperature, to provide an inside rim drive that is positive and "wow" free. The result is an efficient, yet handsomely designed, turntable that is proving its sturdiness throughout the world under the most rigid wartime conditions—and here at home to the complete satisfaction of those who demand a trouble-free turntable for all recording and playback purposes.

Planning for New Equipment?
Consider These Gates Advantages:

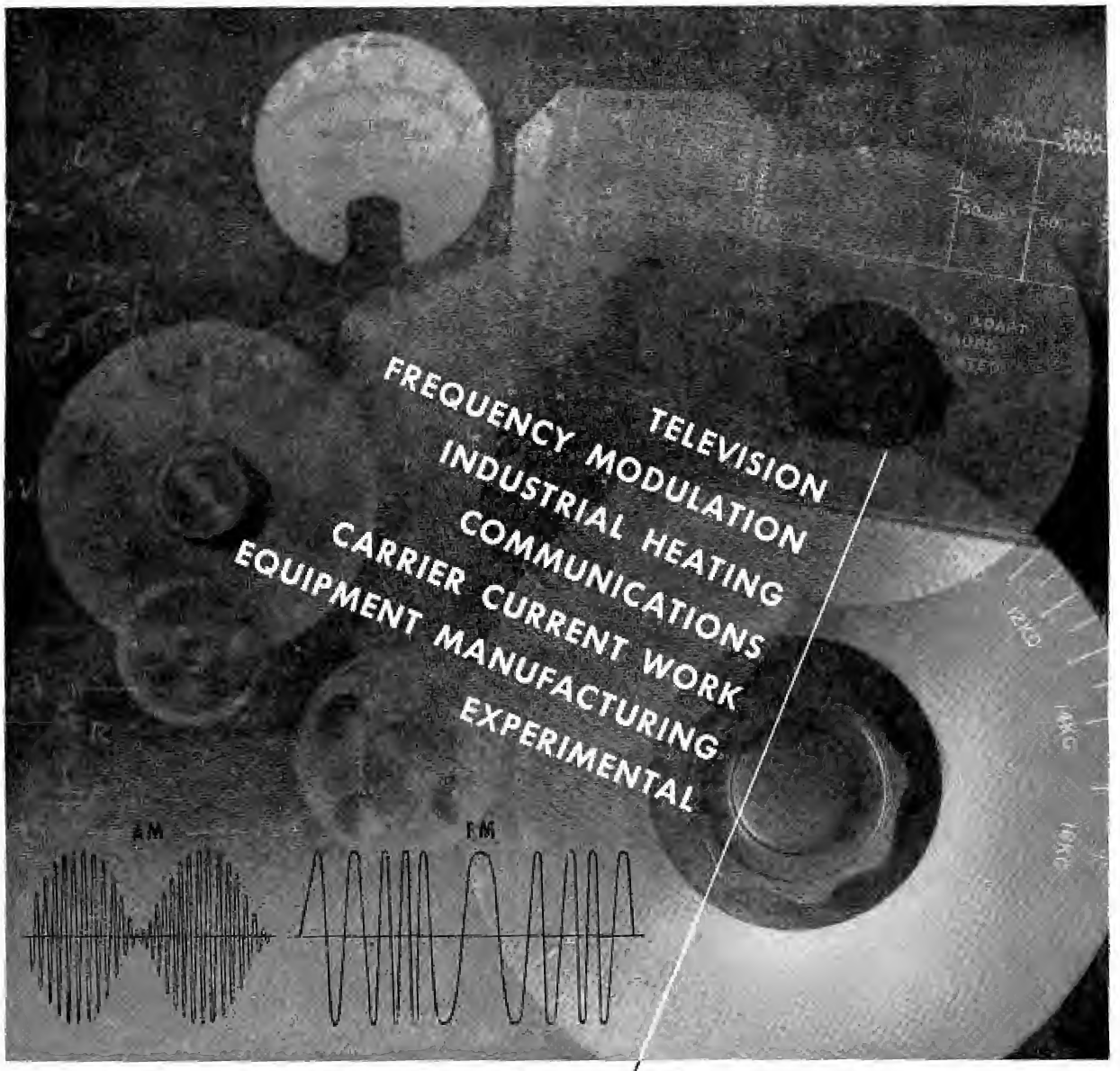
1. Heavy rugged construction combined with precision in its highest form . . .
2. Uses 1/50 HP of inside rim drive. Proved choice of discriminating engineers . . .
3. Inbuilt long life, for years of continuous service with minimum attention . . .
4. Instantaneous speed change combined with "wow" free accuracy and regulation . . .
5. Electrical reproducing set supplied for all popular playback requirements, with accentuating and high fidelity response characteristics . . .
6. Designed for the hardest, most exacting professional usage . . .
7. Ball bearing motor.

Available Now On Proper Priority

(Wartime restrictions do not allow the sale of new broadcasting equipment without priority; therefore, this equipment is presented merely to acquaint you with Gates' developments. Our post-war priority delivery system may be of interest. Write at once for details.)

Gates **RADIO COMPANY**
QUINCY, ILLINOIS, U. S. A.

Manufacturers of Radio Broadcast Transmitters, Speech Equipment, Recording Apparatus and Allied Equipment in the Electronics Field.



Post-war electronics demands new instruments

As the "era of electronics" approaches, it is increasingly evident that the need for more accurate, highly specialized instruments becomes greater. Many of the forerunners of such instruments are already perfected and in use today, but they are still under cover of strict military censorship. When these new developments and others now in the process of development are released—not all, but certainly a good many of the commonly known instruments will instantly become obsolete. In your plans for post-war activity you should make careful note of this fact, for it may save you valuable time in future plant or product conversion.

-hp- instruments are in the vanguard of these new developments. New *-hp-* oscillators, signal generators and vacuum tube voltmeters are setting new standards for rugged construction and split-hair accuracy. Technical data on these and others not yet perfected are, of course, not available today, but the time is not far off when they can be released.

In contemplating the improvement of your laboratory or the alteration of your production with post-war activities in mind, it will pay you to consult *-hp-* engineers. These new instruments may be the answer to your problem. Please give us full details so we can be of maximum assistance.

HEWLETT-PACKARD COMPANY

BOX 931 E STATION A • PALO ALTO, CALIFORNIA

931

CANADIAN OFFICE: 560 KING STREET WEST, TORONTO 2

Casting the International Meter Rods in Paris 1874. The degree of accuracy attained 1/10,000,000 of a quadrant of a terrestrial meridian.

WHO SETS THE *Quality Standard* FOR TRANSMITTING TUBES

UNITED

TRANSMITTING TUBES

IN every art or craft, the work of some acknowledged master sets the standard.

Since 1934 UNITED has won recognition by specializing exclusively in the engineering, design and building of transmitting tubes which are unchallenged for excellence. UNITED tubes excel in every electronic application . . . including radio communication, physiotherapy, industrial control and electronic heating. In these and other applications, tubes by UNITED continue to win top honors for uniformly dependable performance.

In communication equipment for airlines, commercial broadcasting, police radio stations and other vital civilian services, UNITED transmitting tubes set the standard. Accept nothing less than UNITED quality tubes for your requirements.

Order direct or from your electronic parts jobber.

UNITED ELECTRONICS COMPANY

NEWARK, 2 New Jersey

Transmitting Tubes EXCLUSIVELY Since 1934

A matter of inconvenience—nothing more!

OUR stranded friend is the victim of a faulty measuring device. The gauge said "quarter-full" when the tank was empty. The result—a little profanity and an hour's inconvenience.

But not all instruments can be excused so lightly. At work in this war, and in readiness for the years to follow, are thousands of instruments whose accuracy may mean the difference between success and failure, between safety and danger, between life and death. These instruments *must not lie!* Too much depends upon them.

Boes is building instruments of this character. To date, we have not been asked to create instruments in which an element of error could be tolerated. Quite on the contrary, we've been expected to produce instruments of greatest accuracy and, most important, instruments of *sustained accuracy*.* The methods and facilities that are available for this work may be useful to you now, and will certainly be available to you in the years ahead.

• • • • • • •

***SUSTAINED ACCURACY** is not an easy quality to achieve. It must take into account all factors of use—must then employ the design, the alloys, the construction that infallibly protect an instrument against all threats to its reliable performance. Such instruments, obviously, must be built with performance—not price—in mind. We invite the inquiries of those who are interested in such standards.

Boes instruments

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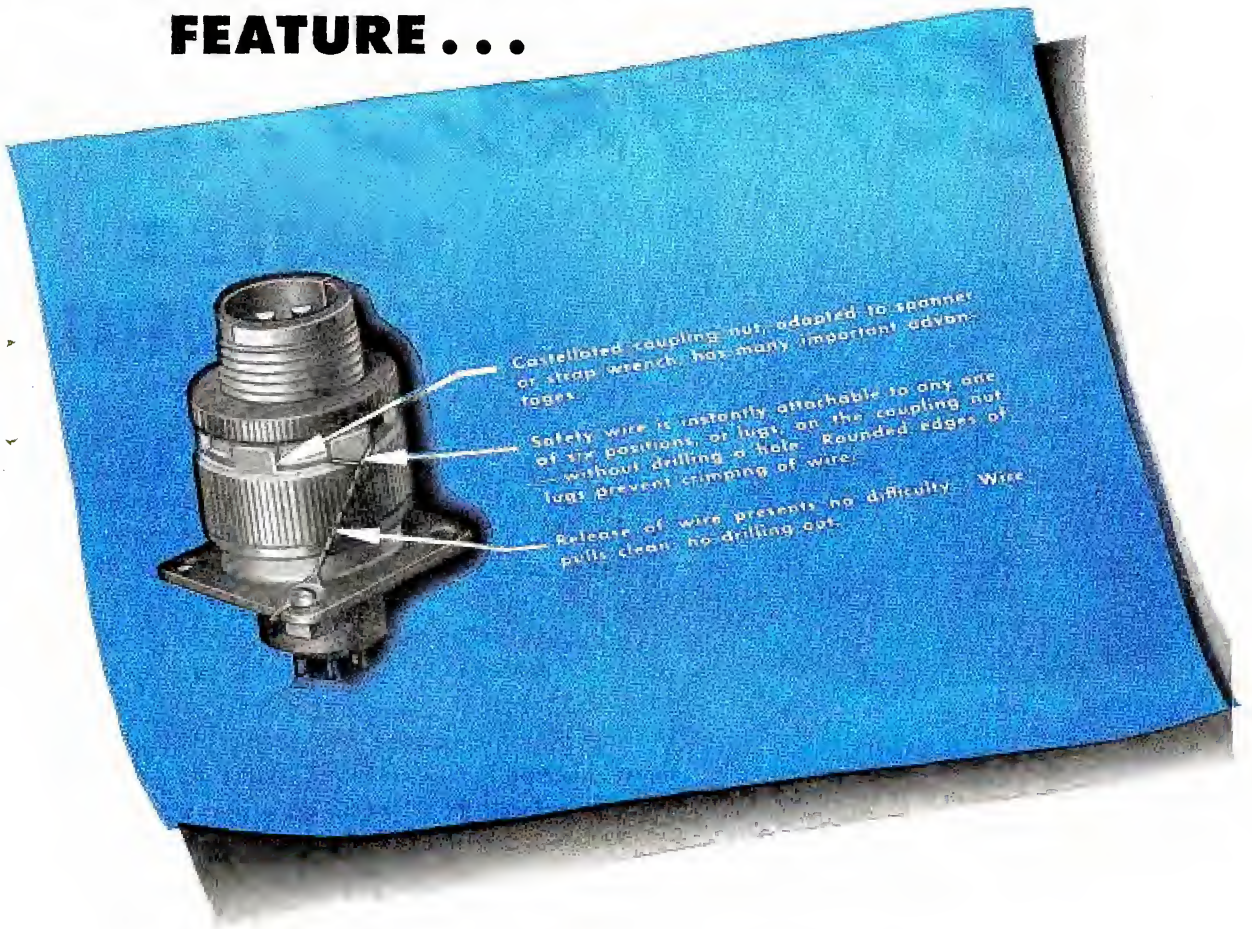

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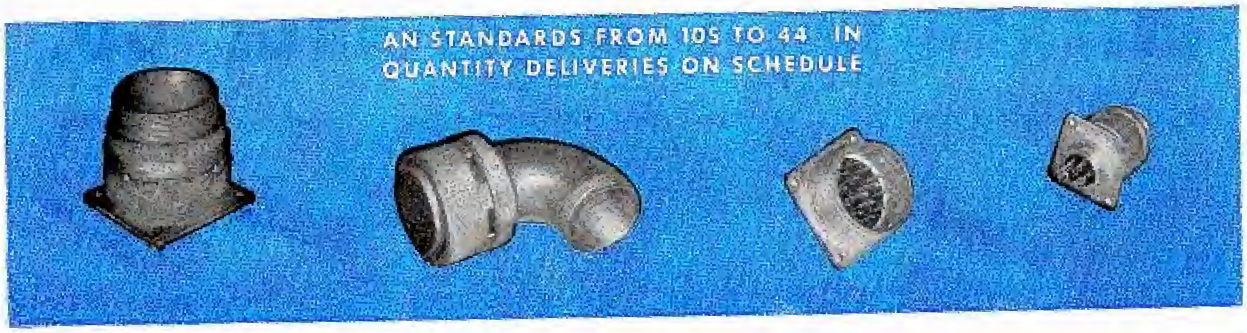

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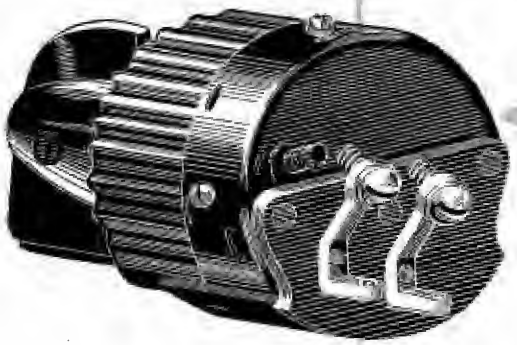

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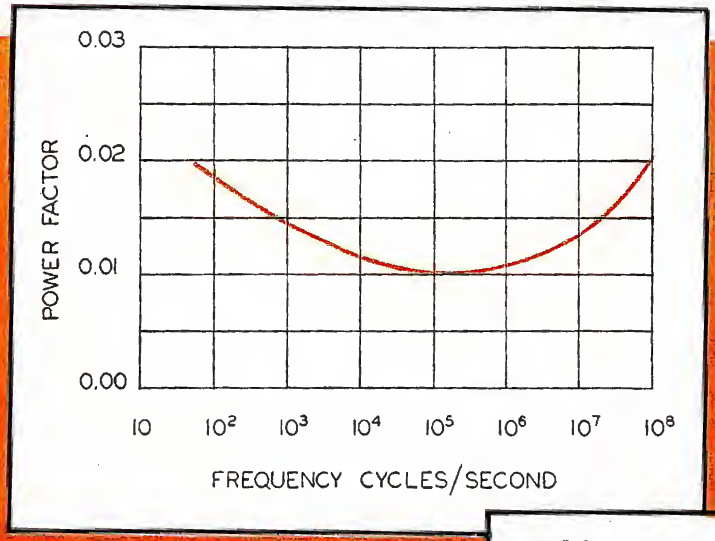

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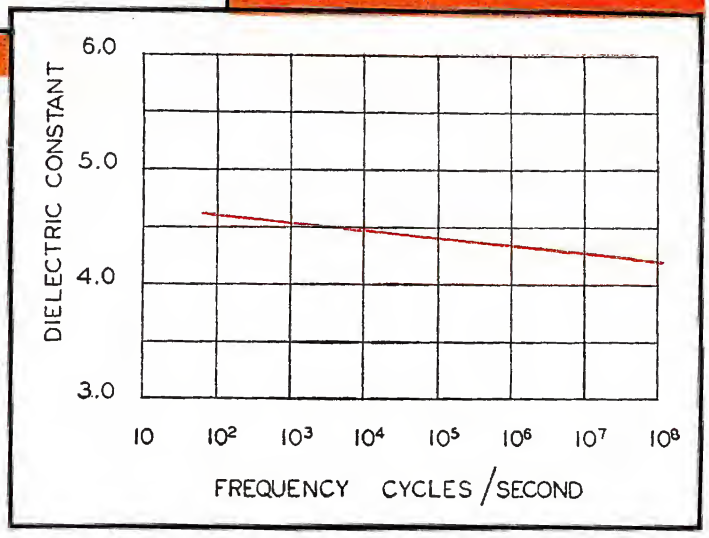

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LEWIS WINNER, Editor

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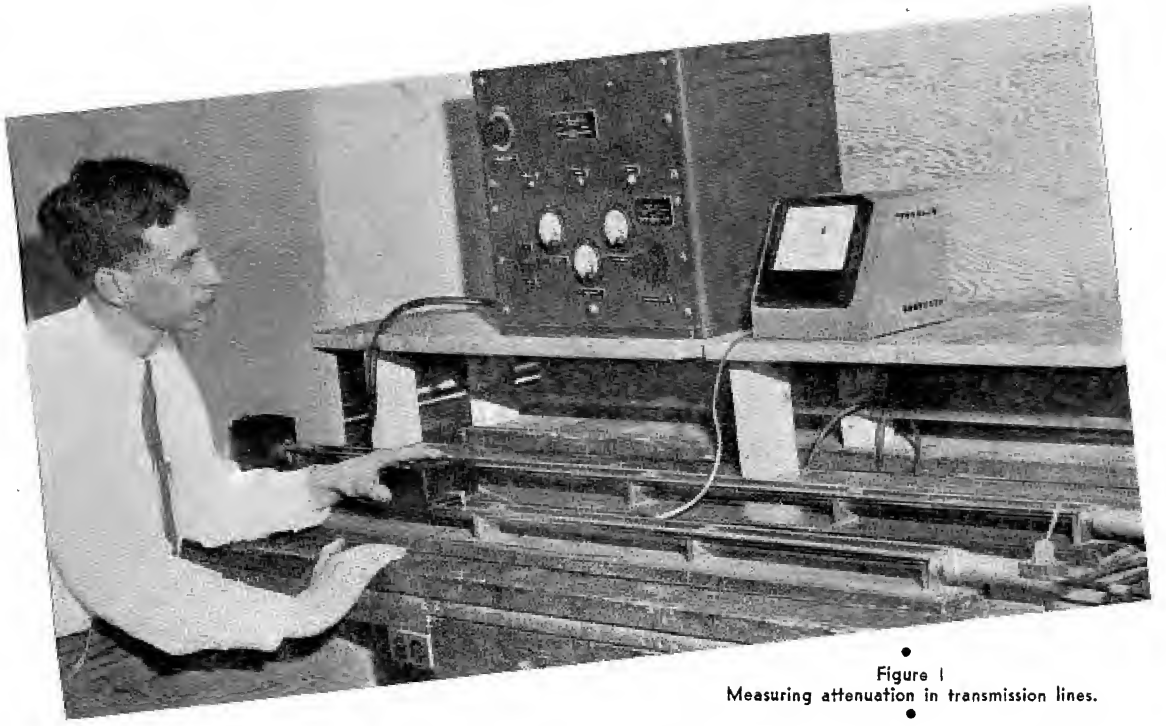


Figure 1
Measuring attenuation in transmission lines.

DIELECTRICS IN U-H-F FLEXIBLE COAXIAL CABLES

by A. J. WARNER

Technical Director

Intelin Division

Federal Telephone & Radio Corp.

MUCH of the communications equipment playing such a large part in the successes of the armed forces of the United Nations could never have been built but for the development of the flexible coaxial cable for ultrahigh frequency transmission and the dielectrics and insulators that made it possible. Although these synthetic materials are the result of years of research by chemists, the nature of them, their enormous possibilities, and their present limitations are vitally important to the communications engineer in order that he may utilize them to the utmost of their capacities.

In essence, such a high-frequency transmission line consists of a central metallic conductor, insulated with a low-loss dielectric material, and outer conductor made by braiding metal wires over the dielectric, and an outer protective sheath. One of the most important electrical properties of a line of this type is its attenuation. This attenuation, or loss, is not a constant value, but varies with frequency, becoming larger as the frequency increases; nor is the rate of increase of attenuation constant with frequency, since the two factors coming into play, namely the copper losses and the losses in the dielectric, vary differently with frequency.

The loss due to the dielectric is given by a very simple formula

$$\alpha d = 2.78 \cdot p \cdot \sqrt{K} \cdot F$$

where

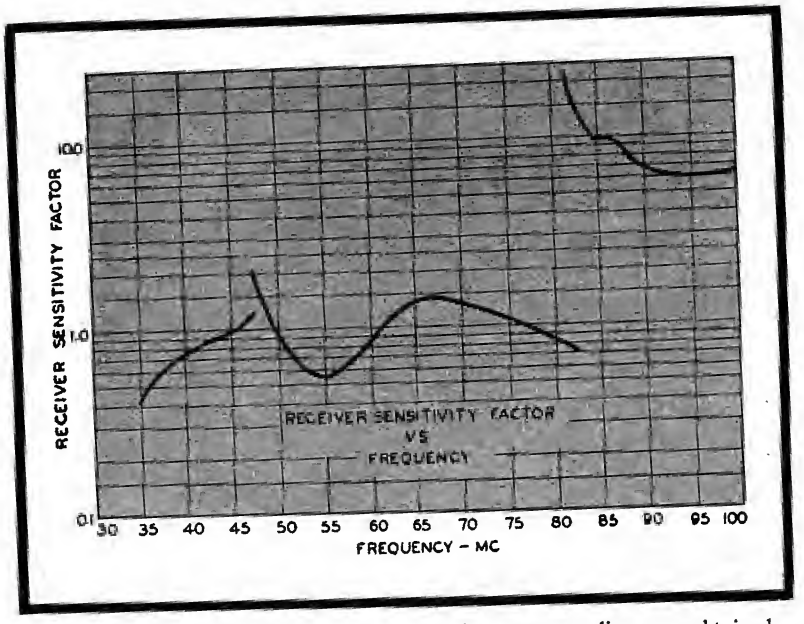


Figure 2
Second set of curves derived from receiver calibrations. Here we have frequency versus receiver sensitivity with respect to sensitivity at 50 mc, as unity.

special attention. The report states that this was set so that the antenna bearing was S 18° W on a horizontal level. At the far end the rhombic was approximately 35′ above ground, and at the receiving end (at the flag pole) it was 14′ above ground. Readings taken outdoors, required the use of an 8′ coaxial leadin to the receiver.

Readings were also taken in the house. Here a 125′ coaxial cable was required. Under the latter setup input voltage signal strengths decreased about 20% to 25%, according to the report.

To obtain input signal strengths, the engineers determined which one of the four arbitrary r-f gain settings would be used to give about mid-range deflection for each station. Thus the maximum ma reading was obtained.

A table, showing signal strengths of stations received at Mt. Greylock, disclosed that WRGB of Schenectady gave best reception. In this instance, the sound input was 15,360 μv with a dipole; the video input was 1,400 μv.

Commenting on the antennas, the report says:

"More precise readings could have been taken had the antenna used been more flexible. An antenna mounted on a 30′ pole which could be swung in the direction of selected station, would be more suitable. A variable wavelength antenna would as well be more desirable than the fixed frequency one used. On the dipole antenna when a station was tuned in at several megacycles above or below the frequency of the antenna, a standing wave or off-resonance condition occurred, and the lead-in cable become very touchy. Reversing the lead-in to the receiver terminals gave a different output reading on the recording instrument. On the rhombic antenna it was noted that if a station was only a few degrees off the direct bearing, reversing the lead-in cable did not seem to have much effect on it. However, if the station was in a direction at right angles to the antenna, reversing the lead-in cable made it very touchy."

Figure 3
Signal strength of television stations received at Mt. Greylock, Massachusetts.

In addition to the tabulated readings, filmed recordings were also made. These included stills of the antenna setups, and motion pictures of stations WNBT, WCBW and WABD during broadcasts.

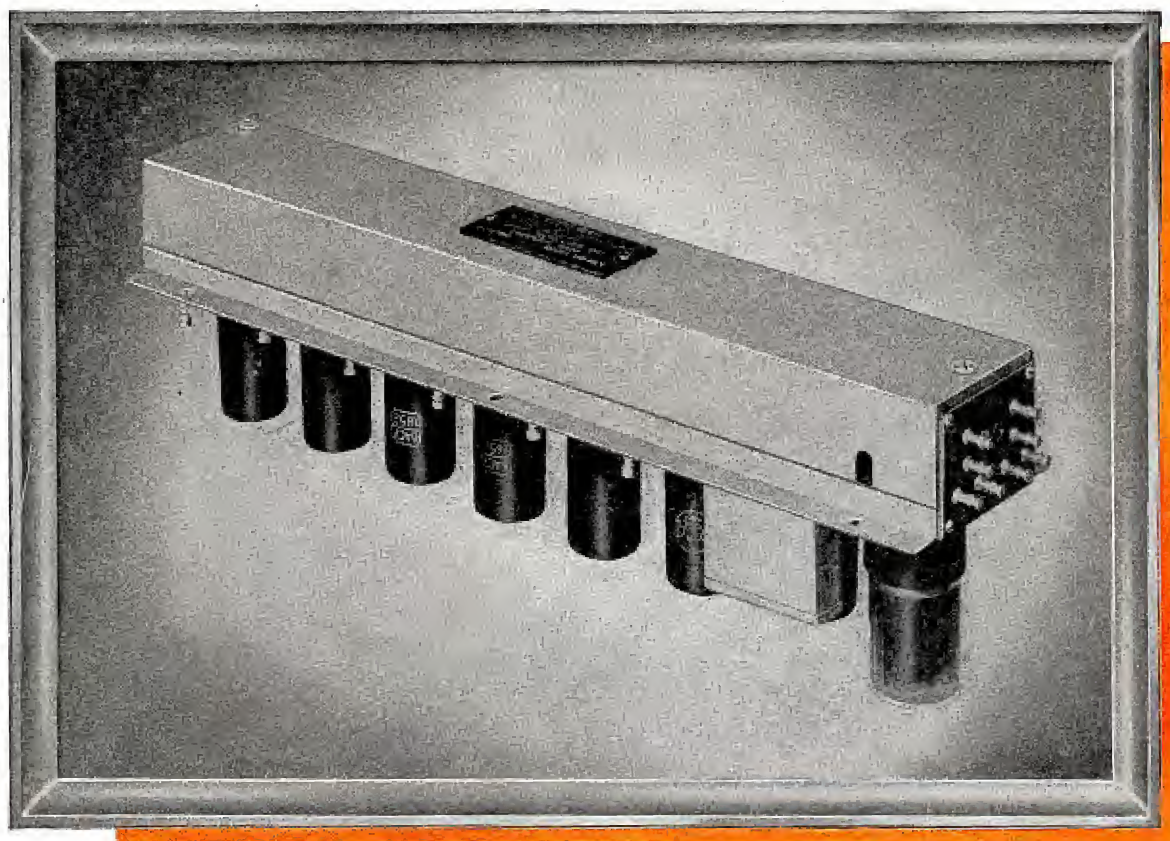
The second test, conducted by O. Y. Brandt, featured graphic recording, using an Esterline Angus graphic recorder.

Two types of antennas were also used in this test; a half-wave dipole and a rhombic, both being horizontally polarized. The dipole was cut to channel 3, or 66-72 mc with a reflector spaced ¼ wavelength. The leadin was 25′ of the copelene coaxial type. An 8-wavelength antenna was used for the rhombic; also for channel 3. A ¼-wavelength matching stub,

(*Continued on page* 88)

Station	Freq. in Mc Sound	Freq. in Mc Video	Station Location	Approx. Airline Distance to Receiver	Date	Time	μv Receiver on Rhombic Sound	μv Receiver on Rhombic Video	Signal Setup	Measured on Dipole Sound	Measured on Dipole Video
WNBT	55.75	51.25	New York, N. Y.	134 mi.	8-2	3-5 PM			f	55.5	20.8
					8-3	noon			f	62.5	48.0
					8-5	evening	623	576	o		
WCBW	65.75	61.25	New York, N. Y.	134	8-2	3-5 PM			f	14.0	4.4
					8-3	evening			f	63.0	19.4
					8-4	evening			f	179.0	164.0
					8-4	evening	364	283	e		
WABD	83.75	79.25	New York, N. Y.	134	8-2	3-5 PM			f	20.3	12.0
					8-2	evening			f	47.0	51.4
					8-6	evening	69.3	25.4	c		
					8-6	evening	73.6	34.6	b		
WRGB	71.75	67.25	Schenectady, N. Y.	40	8-3	evening			g	15360	1400
					8-4	evening	6656	156	e		
					8-6	evening	739	183	a		
WPTZ	71.75	67.25	Philadelphia, Pa.	210	8-4	evening			f	6.2	5.0

Setup a: Readings taken at flagpole, with 125′ copelene leadin.
Setup b: Readings taken at flagpole, with 125′ copelene disconnected.
Setup c: Readings taken in lodge, with 125′ copelene leadin.
Setup d: Readings taken in lodge, with 125′ copelene disconnected.
Setup e: Readings taken at flagpole, with 8′ copelene leadin.
Setup f: Readings taken in lodge, dipole directed to N. Y. C.
Setup g: Readings taken in lodge, dipole directed to Schenectady.
Note: Low μv signals should be corrected for noise.



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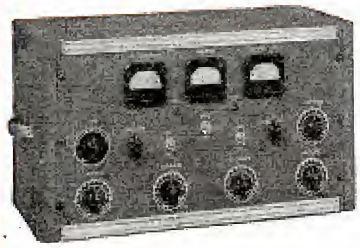

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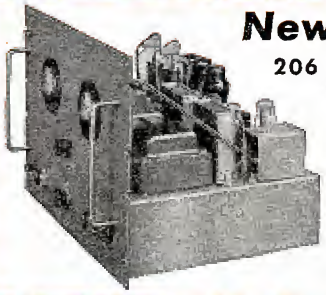

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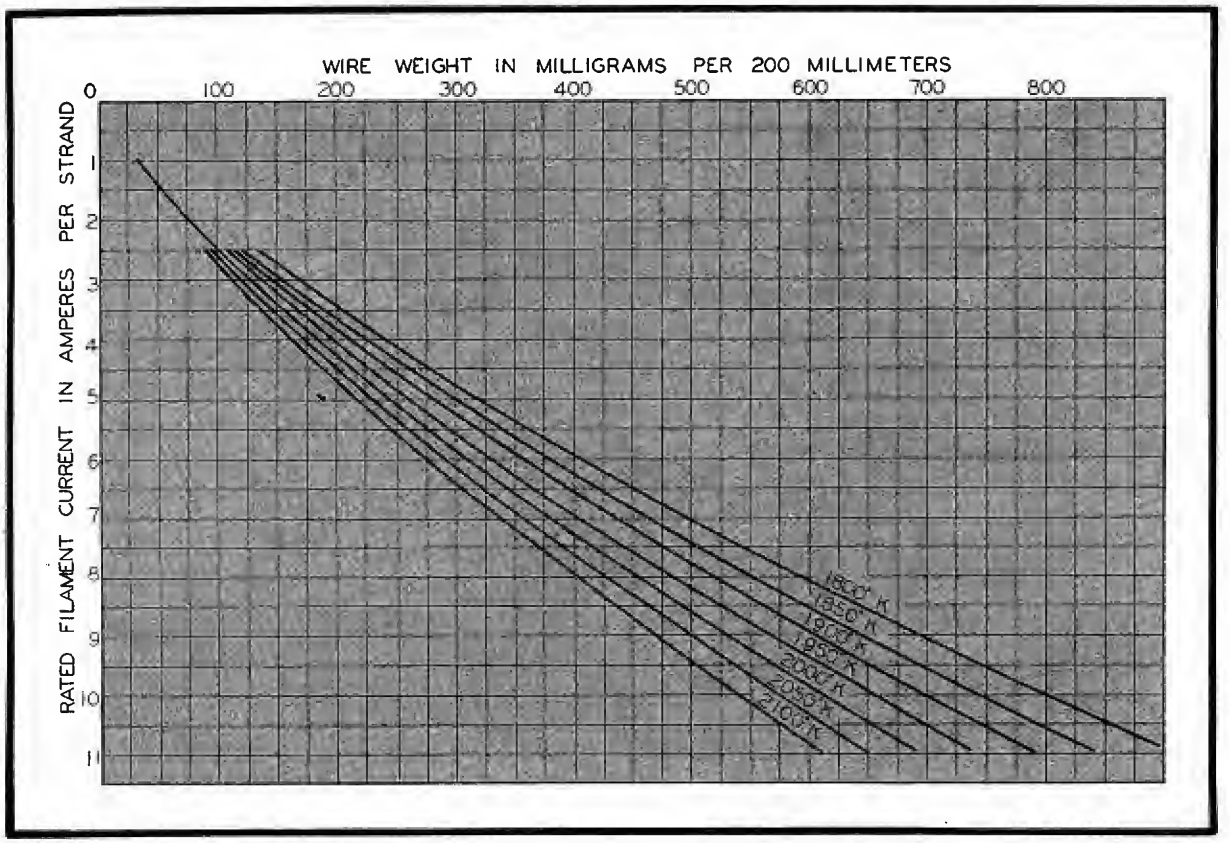


AN intriguing analysis of carbonized thoriated tungsten filaments, disclosing how precalculations may be made, was offered by H. J. Dailey, section engineer, electronics engineering department at Westinghouse, at the Fall meeting. How the same basic calculations may be used on pure tungsten filaments, was also revealed.

Calculations and curves presented covered thoriated tungsten filaments between 1800° and 2200°K and pure tungsten between 2200° and 2800°K.

Discussing why the data developed is applicable to the calculation of carbonized (or carburized) thoriated tungsten filaments, Mr. Dailey said that we know that as a tungsten filament is carbonized its resistance increases and its thermal or power emissivity also increases. This holds true, particularly in the region where thoriated tungsten filaments are useful, explained Mr. Dailey. Accordingly, he said, the increase in resistance increases the watts dissipated per unit of length of the filament, and therefore if the thermal emissivity were unchanged the temperature of the filament would have to increase to radiate the increased wattage.

Thermal Emissivity

It was then pointed out that as the thermal emissivity of the carbonized surface increases by the same percentage as the increase in resistance due to carbonization, it becomes evident that *for the same current* the temperature of the pure tungsten filament and for the carbonized tungsten filament must be the same at some point in the carbonizing cycle, Mr. Dailey said that this holds true at the point where the resistance has been increased by 20%.

•

Figure 1

A family of curves for various filament temperatures versus wire weights.

•

When we carbonize a tungsten filament, said Mr. Dailey, the resistance is usually allowed to increase from 1.15 to 1.25 times the original resistance obtained when passing the rated current for which the filament is being designed; viz., the current at which the filament is to be operated is passed through the filament. Then we measure this initial voltage. And after carbonization, according to Mr. Dailey, we find that the final voltage is from 1.15 to 1.25 the initial voltage or an average increase of 1.2 times the original voltage when measured at the same current.

Since we have found that the power emissivity of a carbonized filament is apparently independent of the degree of carbonization (providing the wire does not develop surface cracks, as such cracks act as black body radiating surfaces), explained Mr. Dailey, we may make a calculation of the expected variation in temperature due to variations in the percentage of carbonization.

Explaining the error factor, Mr. Dailey said that we may expect an error in temperature of approximately ± 1%, for a range in carbonization between a voltage increment of 1.15 and 1.25. These calculations, he said, hold for a filament operated at fixed filament current.

While it is possible to calculate the variation in temperature with variation in filament current due to variation in percentages of carbonization when measured at constant voltage, Mr. Dailey showed that it is more convenient to plot a family of curves for various temperatures in the range being explored and pick off the temperatures from the curves, Figure 1. Explaining these curves, Mr. Dailey said that the variation of temperature due to variations in wire diameter may be seen by studying the abscissa in the range in question. The ordinates reveal the variation in temperature with filament current. If we analyze the variation in filament wire weight and variation in filament current, we will note that these two define a rectangle which has at its center the point provided by a calculation of the wire size (mean dimension) and the mean of the filament current design center, pointed out Mr. Dailey.

Explaining the ratio of two adjacent sides of the rectangle Mr. Dailey said that it is more important to hold filament current within close limits than it is wire weight.

Mr. Dailey also pointed out that it is useful to know the percentage of carbonization in the ratio of the cross-section of the filament composed of W_2C to the

ROCHESTER FALL MEETING

Highlights of Papers Presented By H. J. Dailey, M. J. Larsen, W. R. MacLean, E. Labin, T. W. Dakin and S. L. Bass

by LEWIS WINNER
Editor

total cross-section of W + W_2C. These are readily calculable, he said, since we know the resistivities of the two materials.

Analyzing this, he stated, that the resistivity of pure tungsten at 2000°K = 59.4 x 10^{-6} ohm cm. Thus, he said, the resistivity of W_2C at 2000° K = 121 × 10^{-6} ohm cm.

And for operation at 2000°K we have:

Resistance increase (at operating current)	% of total area composed of W_2C	Total resistivity in ohm cm
1.057	10	62.7×10^{-6}
1.115	20	66.2×10^{-6}
1.18	30	70.0×10^{-6}
1.255	40	74.7×10^{-6}

Accordingly by determining the voltage increase at the design center filament current it is possible to predict what percentage of the cross sectional of the filament will be tungsten carbide, according to Mr. Dailey.

In a discusssion of the helical filament, Mr. Dailey said that the calculations given do not theoretically hold for these filaments practically. However, he said, they are quite useful. For, he pointed out, if the ratio of the distance between the center of one filament turn and the center of the adjacent turn to the diameter of the wire is greater than 5, the calculations may be used with a negligible error. If this ratio is less than 5 the following relation can be applied:

$$A = B - \left(\frac{r}{d}\right)^2 B, \text{ where}$$

A = current required for helical filament.
B = calculated current for straight filament of same wire size.
r = radius of wire
d = center to center distance

Mr. Dailey explained that while this relation will not apply to a rigorous mathematical analysis, for most practical purposes it is quite sufficient.

•

VIDEO AMPLIFIERS

IN a paper on L-F Compensation of Multi-Stage Video Frequency Amplifiers, Dr. M. J. Larsen of the Stromberg-Carlson research department discussed the contribution of the impedance elements in control grid, screen grid and plate circuits to distortion of a transmitted square wave, which appears as a rounding of the flat top.

Multiple Stages

In introducing his analysis, Dr. Larsen said that the problem of holding phase shift and amplitude characteristics in a multi-stage video amplifier within prescribed limits becomes increasingly difficult as the number of stages is increased. When we depart from the optimum phase and amplitude characteristics in such an amplifier, we find that the amplifier is not able to pass 1-f square waves without either rounding or tilting, or both, of the wave, explained Dr. Larsen.

When an amplifier is adjusted experimentally to pass 1-f square waves, it is common to vary the grid resistance following the stage involved until the output waveform is symmetrical, pointed out Dr. Larsen. A fundamental component somewhat enlarged causes the waveform rounding, he said, but in proper phase. When we square the waveform, we generally try to eliminate tilt, or obtain zero phase shift of the fundamental component, he explained. Such a procedure, he said, leaves an augmented fundamental, as it is impossible in conventional circuits to compensate for phase shift and amplitude change simultaneously. Since the third, fifth and higher-odd components of the square wave have neglible change from their normal amplitude or phase, Dr. Larsen said that the effect of the fundamental only need be considered.

Probing the rounding of the square wave problem, Dr. Larsen pointed out that this rounding may be conveniently expressed as the increase over the normal amplitude of the fundamental component divided by the normal amplitude, or

$$\frac{\Delta E}{E_{g2hf}} = \frac{E_{g2lf} - E_{g2hf}}{E_{g2hf}} \cong \frac{X_f^2}{R_L R_f} + \frac{X_f X_d}{R_L r_{sc}} \quad (1)$$

where E_{g2hf} is the peak value of the a-c wave:

Or

$$\frac{\Delta E}{E} \cong \frac{2}{\pi}\left(\frac{X_f^2}{R_L R_f} + \frac{X_f X_d}{R_L r_{sc}}\right) \quad (2)$$

where E is the peak to-peak value of the square wave.

Dr. Larsen explained that the first term in expression (2) is the rounding contributed by the plate circuit, while the second term is that contributed by the screen. He offered a comparison of the relative contributions of the plate and the screen using the values: $C_f = 20$ mfd, $R_f = 10{,}000$ ohms, $C_d = 10$ mfd, $R_d = 56{,}000$ ohms, $R_L = 1{,}000$ ohms, $f = 20$ cycles.

Thus, he said, the rounding contributed by the plate is

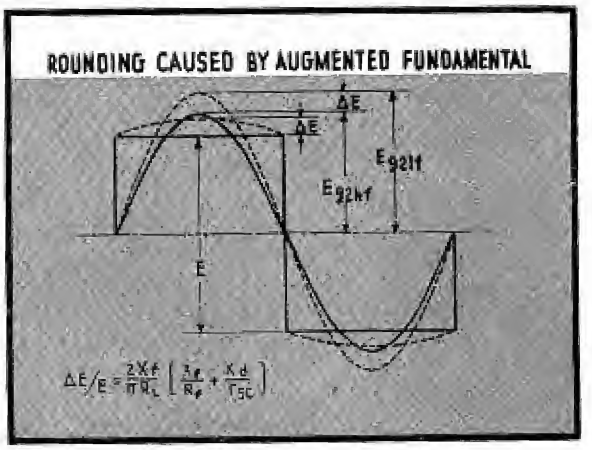
$$2X_f^2/\pi R_L R_f = 1\%$$

and that by the screen is

•

Figure 2

A square wave showing rounding by an augmented fundamental component. Upper curves show amplitude changes with and without screen compensation, analyzed by Dr. Larsen.



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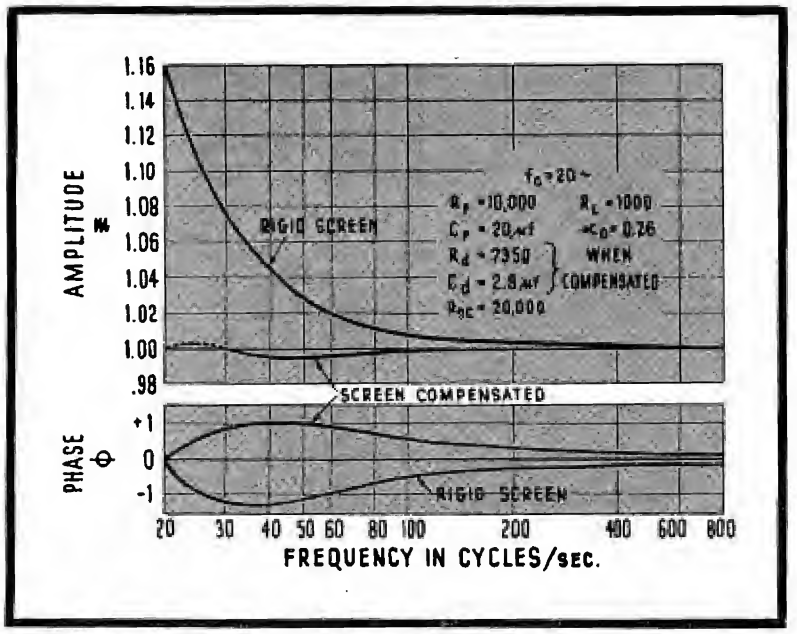

Figure 3
Comparison of amplitude and phase distortion with and without screen compensation.

$$2X_fX_d/\pi R_L r_{sc} = 1\%.$$

In view of this finding, the total rounding is 2%, of which 1% is contributed by the plate and 1% by the screen. Obviously, he said, a larger screen filter capacitance should be used and possibly a larger plate filter capacitance.

To complete a design, explained Dr. Larsen, it is necessary to evaluate the grid-coupling resistance and the coupling capacitance. Thus under balanced conditions, or when a symmetrical square wave is obtained, we find that the grid resistance and coupling reactance are proportional respectively to the real and imaginary components of the plate voltage, he said.

For most practical applications where final adjustment usually would be made experimentally, Dr. Larsen offered the approximate design ratio

$$R_g/X = R_L/X_f \qquad (3)$$

which is often written as

$$R_gC = R_LC_f$$

With the circuit values cited previously, at a frequency of 20 cycles, expression (3) provides

$$R_g/X = 2.5$$

We thus find that the correct value of R_g is about 15% larger on the basis of the approximate expression, he said. This, however, he explained, corresponds with what is observable experimentally.

In discussing practical considerations, Dr. Larsen stated that where the screen reactance is high enough to cause considerable rounding, the dynamic screen resistance enters into the calculations. Therefore, he said, because of the wide variation in the screen resistance among different samples of tubes of a given type, replacements of tubes is likely to cause a tilt of the previously balanced wave. It is wise therefore, he explained, to bypass the screen with a sizeable capacitance and thereby minimize the effect of variations in screen resistance.

Rounding, according to Dr. Larsen, is directly proportional to the number of stages. He pointed out that 1% rounding in one stage, for example, would be hardly noticeable, but this would lead to 10% in ten stages which may be altogether excessive.

An interesting calculated comparison of screen compensation versus a rigid screen was presented by Dr. Larsen. Figure 3, in which 10 stages of amplification were assumed. The plot reveals that the amplitude distortion is relatively negligible while using screen compensation. Dr. Larsen said that both curves start with zero phase shift, as balanced adjustment was assumed, and vary about the same amount with frequency. He stated that a comparatively small screen filter capacitance was required.

Covering the practical limitations of screen compensation, Dr. Larsen said that were it not for the fact that the dynamic screen resistance influences the performance of a screen compensated stage, this type of compensation would be most excellent. He said that in some cases the filter resistance used in the screen for compensation becomes quite low and unless special power supplies are used, additional filtering may be necessary to minimize overall regeneration. In addition, he said, too large voltage swings on the screen may result in distortion in stages having a large output voltage. Where however the screen resistance can be maintained relatively constant, this type of compensation is very practical, he pointed out.

An interesting series of experimental tests were also described by Dr. Larsen. He said that the tests were run on a nine-stage amplifier, with the gain reduced every third stage so as to prevent excessive grid swing. Dynamic screen resistances were measured for the individual tubes, explained Dr. Larsen, and under controlled conditions, screen compensation showed a marked advantage over the case when the screens were maintained rigid. Random interchange of tubes, however, he said, usually disturbed the wave form seriously, as the tubes varied considerably with regard to their screen resistances.

Dr. Larsen explained that slight changes in waveform occurring between the reference frequency (20 cycles) and the higher frequencies indicated that the experimental results followed the trends predicted by the calculated curves, as shown in Figure 3, for instance.

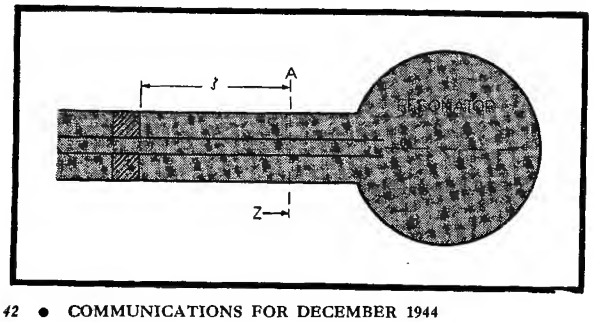

Figure 4
Impedance into general resonator measured at section A (MacLean paper). As ζ is varied, frequency changes.

RESONATORS

THE reactance theorem for a resonator received an effective analysis by W. R. MacLean of the graduate electrical engineering department of the Polytechnic Institute of Brooklyn. His paper took as its point of departure the well-known Foster theorem of network theory which states that in any non-dissipative two-terminal linear passive network (i.e., one made up of coils and condensers only and without iron saturation), the slope of the reactance curve as a function of frequency is always positive.

Mr. MacLean undertook to prove this same theorem for the case of a *lossless electromagnetic enclosure:* any sort of disposition of perfect conductors within an enclosing shield which is fed through a shielded transmission line. The proof was based upon certain very general energy relationships. Interesting was the fact that instead of using a variable frequency source, the frequency variation was obtained by moving a plug in the transmission line, while the cavity is oscillating. (This is similar to tightening a violin string while it is vibrating). In the proof, use was made of an old heat theorem of Helmholtz.

PULSE TIME MODULATION

THE development of a system of pulse time modulation, was revealed by E. Labin of the Federal Tele-

(*Continued on page 46*)

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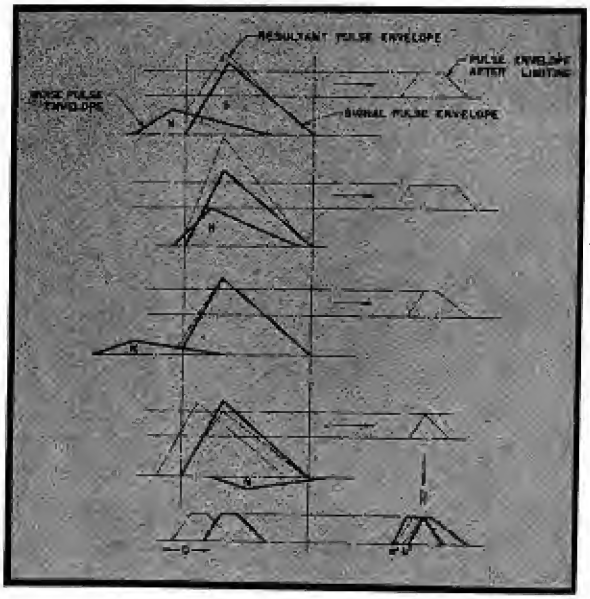


Figure 5

An idealized pulse, discussed by E. Labin, represented by a triangle, with noise represented by a similar triangle of lower amplitude and same duration. Representation of noise and pulses by triangles of the same shape is justifiable because the shape is actually determined by the frequency band of receiver. Distortion introduced in the desired pulses by different noise pulses is also indicated here.

Figure 6 (below)
Arrangement of resonant-cavity apparatus for measurement of dielectric properties by wavemeter method.

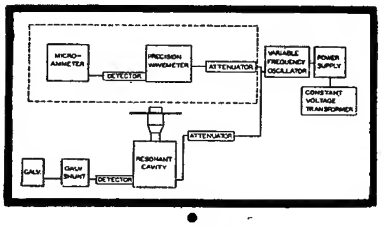
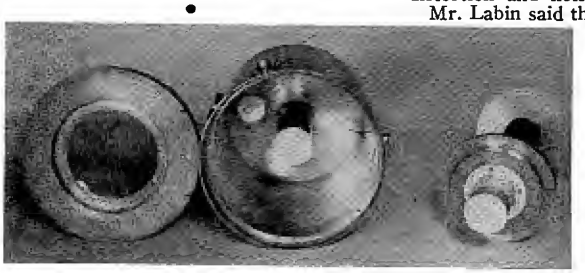


Figure 7 (below)
Interior views of cavities used at 200 megacycles.



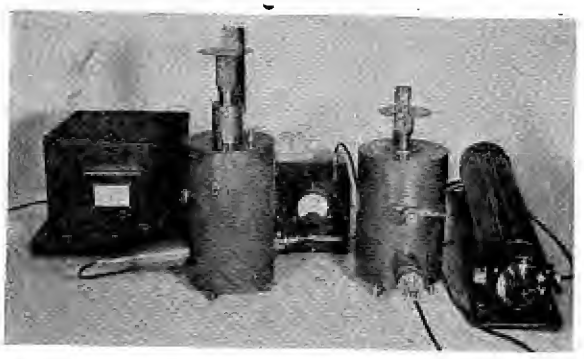


Figure 8
(Left, below)

Measuring equipment for 200 megacycles. Left to right: galvanometer, measuring cavity, microammeter, oscillator and constant voltage control.

(*Continued from page* 42)

phone and Radio Laboratories, at one of the Fall meeting sessions.

Describing this form of modulation, Mr. Labin said that it consists essentially in transmitting intelligence by pulses of constant amplitude and duration. The instantaneous amplitude of the voice is translated into a variation of time intervals of successive pulses, the rate of this variation corresponding to the instantaneous frequency of the signal. The bandwidth is determined by the steepness of the pulses which can be adjusted according to the type of operation desired.

Some of the advantages disclosed were simplification derived from use of more rugged repeaters, capable of operating on trigger action, thereby materially reducing the usual requirements for stability, distortion and noise.

Mr. Labin said that research and development work on this project began in the Paris Laboratories of I. T. & T. in 1937.

Mr. Labin stated that pulse modulation improves the signal-to-noise ratio, offering some theoretical results to show quantitatively how this improvement depends upon the frequency band used.

He pointed out that a receiver for any type of modulation can be divided into: (*a*) A linear amplifier followed by a linear detector; (*b*) A series of limiters introducing a fixed or adjustable amplitude gate; (*c*) A converter or demodulator restoring the audio characteristics of the original signal; and (*d*) A series of audio filters eliminating all frequencies not used in the desired signal, followed by audio amplifiers which bring the signal to the desired level.

In an a-m system, (*b*) does not exist, said Mr. Labin, and (*c*) is identical with a linear detector which we have supposed to be included in (*a*). In other words, in this a-m system, the whole receiver can be considered as a linear system insofar as the relationship between the output audio signal and the original audio signal at the transmitter and the output and input signals are concerned.

In an f-m system, said Mr. Labin, (*b*) generally precedes the linear detector of (*a*), and (*c*) is represented by a discriminator of more or less conventional type.

In pulse modulation, (*b*) may precede or follow the linear detector and (*c*) is some type of demodulator circuit, explained Mr. Labin.

The essential difference of t-m (time modulation) and f-m as compared to a-m is that the receiver is no longer a linear system, according to Mr. Labin. Continuing this analysis, he said: "The relation between the audio output signal of the receiver and the audio input signal at the transmitter obviously must be linear but, in the receiver itself, nonlinear devices considerably distort the signal-noise relationship. This difference, in an f-m or t-m receiver, necessitates the introduction of the concept of output signal-to-noise ratio as opposed to input signal-to-noise ratio. The input signal-to-noise ratio is the ratio which exists at the input of (*a*) or at the input of (*b*). This ratio is simply the ratio of the amplitude of the incoming wave to the amplitude of the noise (or, if preferred, the ratio of the corresponding powers).

"Such a ratio depends essentially on the field strength at the receiver or, for identical propagation conditions, on the transmitted power and on the frequency band of the receiver.

"The relation between the frequency band and the amplitude of the noise is well known. It signifies that the equivalent power generated by the noise is proportional to the frequency band of the receiver.

"The output signal-to-noise ratio is actually the important factor, and represents the ratio of the audio output signal to the audio output noise."

U-H-F MEASUREMENTS

A RESONANT cavity method for measuring dielectric properties at u-h-f, described by Dr. T. W. Dakin, of the insulation department at Westinghouse, revealed how a reentrant cylindrical cavity was adapted to measure the dielectric constant and power factor of small disc samples of insulating materials. Several different sized cavities were used

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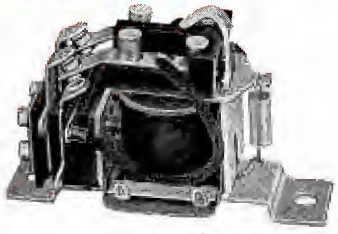

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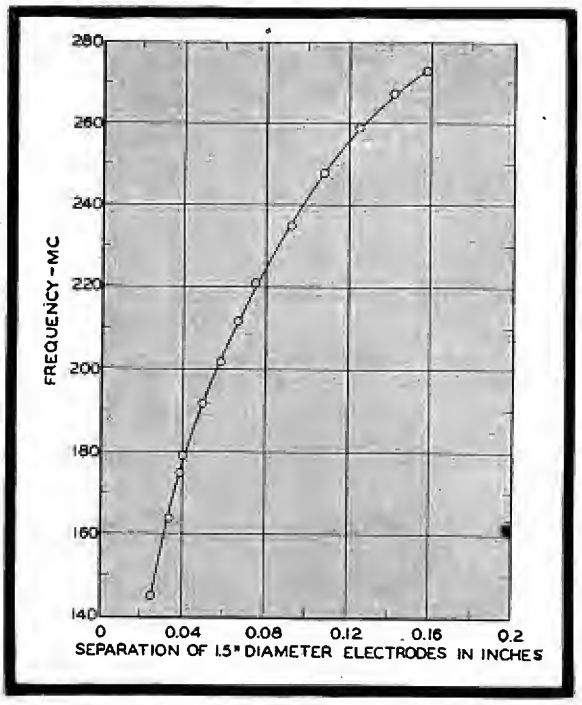
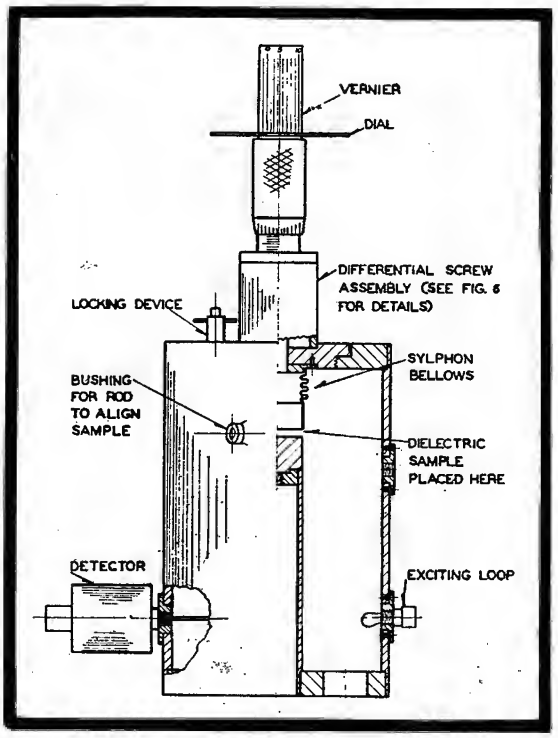




Figures 9 (above left) and 10 (above)
Figure 9, relation between resonant frequency and separation of electrodes of 200-mc cavity. Figure 10, reentrant cavity used for measuring dielectric properties.

to cover a range of frequency from 50 to 1000 megacycles. An accuracy of ±.00005 in tanδ and ±% in dielectric constant was available according to Dr. Dakin. The cavity's high Q (> 2000), affords greater sensitivity to low power factor dielectric samples than any conventional coil and capacitor resonant circuit, explained Dr. Dakin.

Typical results of measurements of dielectric properties at about 200 megacycles

Material	Thickness of sample inches	Dielectric Constant	Dissipation Factor
Micarta #254 (Cresol-Formaldehyde; resin paper filled)	0.150	3.72	0.047
Columbia Resin CR-39	0.149	2.96	0.027
Pure fused quartz	0.206	3.79	0.0001
Polystyrene sample A	0.150	2.55	0.0003
Polystyrene sample A	0.100	2.565	0.0003
Polystyrene sample A	0.250	2.56	0.0003
Polystyrene sample B	0.151	2.56	0.0005
Polyvinyl Carbazole	0.115	3.06	0.0009
Special Styrene Copolymer	0.183	2.64	0.008
High Tension Porcelain	0.186	5.90	0.010
Zircon Porcelain	0.178	9.5	0.0008
Ultra Steatite	0.215	5.23	0.0007
Steatite	0.247	5.45	0.0034

SILICONES

SILICONES, the new dielectric that is characterized by its high order of heat stability, were discussed by Dr. Shailer L. Bass, director of research at Dow Corning Corporation, at the meeting. Dr. Bass explained that communications equipment has depended upon two broad classes of dielectrics; organic and inorganic. He said that the organic insulations, which are essentially compounds of carbon, are used in a variety of physical forms varying from molded plastics and wire coatings to potting compounds, cements, and liquid or wax impregnants. They fill the need for average temperature requirements. However, he said, when the service requires stability at elevated temperatures, the organic dielectrics soon reach a temperature limit of effectiveness. One reason for this, he explained, is the inherent instability of the carbon-to-carbon linkage. That is, he said, the rate of aging, determined by the time for the insulation to fail the test for a given

(*Continued on page* 50)

Figure 11
Arrangement of cavity equipment for measuring dielectric properties of material by frequency modulation method.

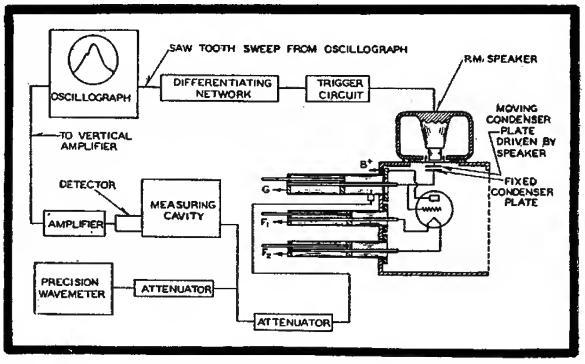
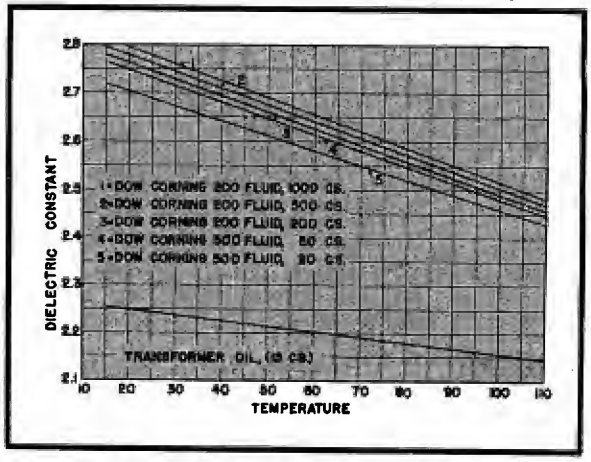


Figure 12
Effect of temperature on dielectric constant of liquid silicones, discussed by Dr. Bass, as compared to typical transformer oil of petroleum origin.



☆

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Abraham Lincoln, 1861

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IRE REPORT

(*Continued from page* 48)

physical property, such as flexibility, follows pretty closely the rule of half the life for every rise of ten degrees centigrade in temperature. And the eventual thermal decomposition product of organic dielectrics is carbon. Accordingly, explained Dr. Bass, the end result of exposure of organic insulating materials to elevated temperatures is to change a dielectric to a conductor.

In the inorganic spacing materials we have a framework of silicon and oxygen atoms, the two most abundant elements in the earth's crust. In this group we find quartz, vitreous silica, glass, asbestos, mica and ceramics. These materials are all high polymers, large molecules, explained Dr. Bass. And their molecular framework is essentially a structure of silicon atoms bound to each other through oxygen atoms, with a heat stability due to the inherent stability of this silicon-oxygen-silicon bonding. Unfortunately, said Dr. Bass, these materials are limited in physical forms to comparatively hard, brittle solids.

Explaining silicones, Dr. Bass said that they are a new class of semi-inorganic high polymers based upon silicon and oxygen instead of carbon, bridging the gap between the completely organic products and completely inorganic materials. Dr. Bass said that silicone products include liquid dielectrics, lubricants, greases, resins and varnishes, etc.

There are two groups of liquid silicones, based on the range of viscosity and service temperature to be covered: (*a*)—for use down to —55° C and below; and (*b*)—for use down to —40° C and up to 200° C. Dr. Bass said that all viscosity grades in this type are non-volatile liquid dielectrics with an even lower rate of viscosity change with temperature than the lighter viscosity fluids of (*a*).

Liquid silicones are noncorrosive to metals and are nonsolvents for rubber, synthetics and other organic plastics, said Dr. Bass. He said that their flash points are considerably higher than petroleum oils of equivalent viscosity and they will burn, when once ignited, to form silica, carbon dioxide and water. Discussing surface tension, he said it is low, about 20 dynes per cm, and they readily wet clean, dry surfaces of glass, ceramics and metals, making them water repellent; they are insoluble in water and are unaffected by water, dilute acids or salt solutions. They are soluble in most organic solvents including carbon tetrachloride and aromatic naphthas, but are insoluble in alcohol and acetone, pointed out Dr. Bass.

The power factors of the fluids are unusually low, said Dr. Bass, being less than .0001 at ordinary frequencies, and they do not increase appreciably with increased frequency up to 10^7 and 10^8 cycles. At higher frequencies, however, explained Dr. Bass, there is evidence of a more rapid rise in power factor. Their dielectric strength is 250-300 volts per mil at 100 mils; volume resistivity is in the order of 10^{14} and does not drop below 10^{12} at 200° C, he said. In view of these dissipation factors at elevated temperatures or at high frequencies and their inertness to moisture, they are useful in liquid filled condensers, said Dr. Bass.

The introduction of silicone varnishes with their greater thermal stability has

provided a very effective insulation, said Dr. Bass. He said that silicone resins are useful for filling voids and excluding moisture from equipment insulated with fiberglass, mica or asbestos.

One varnish developed is used to bond fiberglas or asbestos served magnet wire, to varnish fiberglas or asbestos tapes, cloths and sleeving, and as an adhesive for bonding mica sheets to silicone varnished fiberglass cloth in the production of a flexible ground insulation.

This new silicone insulating varnish is applied and handled in a manner exactly similar to conventional organic varnishes except that higher baking temperatures are required, explained Dr. Bass. He pointed out that after drying off the solvent, the equipment is usually given an intermediate bake for 2 to 4 hours at 150° C after which it is cured for 1 to 3 hours at 250° C until the varnish becomes tack-free. This baking, he said, converts the silicone to a hard but flexible resin which effectively seals the equipment against moisture; it is not deteriorated by oil and is unusually resistant to chemicals.

The higher operating temperatures possible with silicones, also make possible higher output by simply adding more load on an existing design, said Dr. Bass. In one instance, a 10 h-p motor built with silicon insulation was one-half the size and weight of a standard type unit, according to Dr. Bass. He said that the silicone motor will probably outlast the conventionally insulated motor because it does not carbonize when overloaded and the moisture proofness is retained on long aging at elevated temperatures.

Thermosetting silicone resins were also discussed by Dr. Bass. He said that many types of electrical insulation constructions require thermosetting resins for use in their fabrication: laminated board, coil forms, tubes, slot sticks, and laminated mica. There are several types of silicone under development for bonding Fiberglas and asbestos textiles to each other or to mica, he explained. These resins are supplied in solution, he said, and used to coat or impregnate the product to be laminated. The resulting coated cloth or sheet can be laminated in the conventional press at temperatures of 230° to 250° C, according to Dr. Bass.

Figure 13
Glass coil forms treated with liquid silicones, showing highly water repellent surface. When exposed to high humidities under condensing conditions, silicone film prevents moisture from forming continuous liquid film.

GRAPHICAL SOLUTION FOR CAA COURSE ALIGNMENT

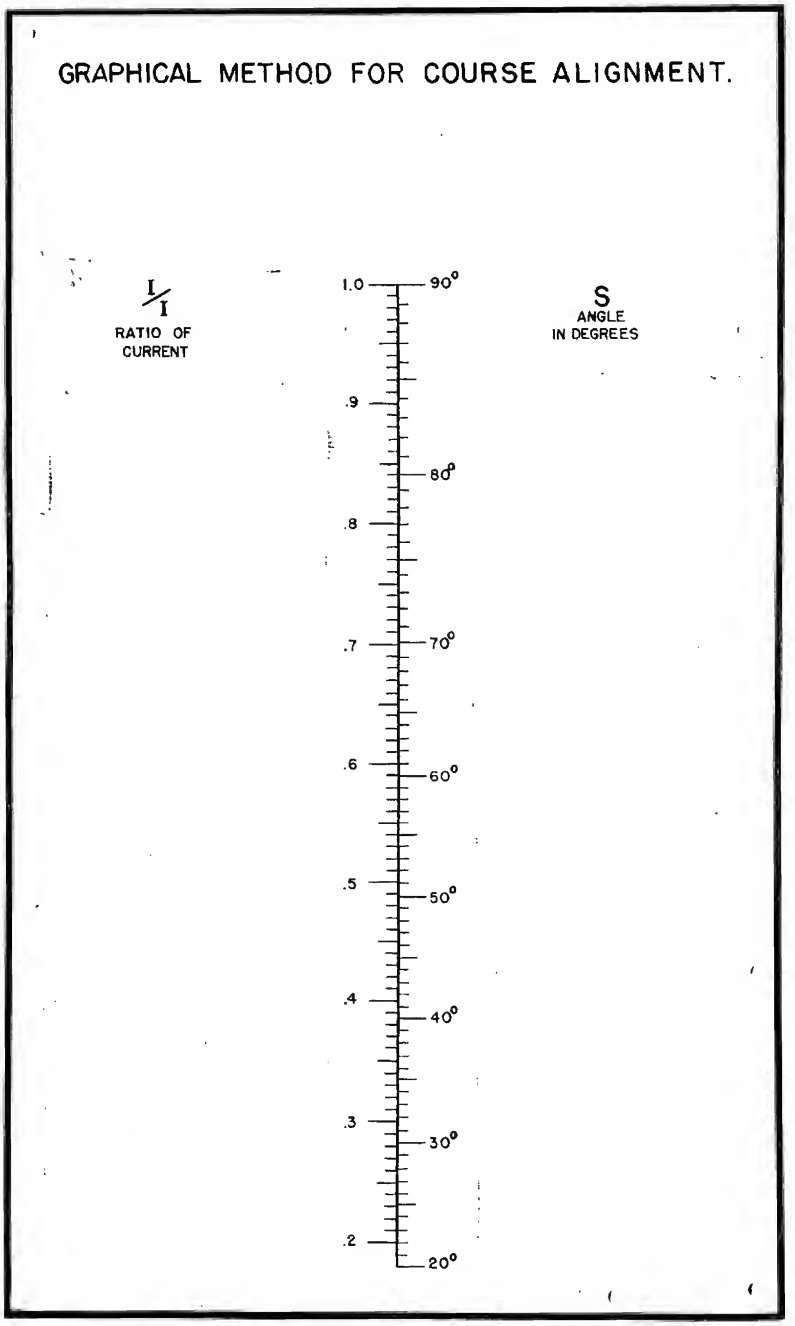

Chart 1

[*PART TWO OF A TWO-PART PAPER*]

by G. L. BREWER

Chief, High Frequency Unit
Signals Division, CAA

A graphical method employed by the CAA for determining the adjustments necessary for properly orienting the four courses of a CAA radio-range station employing the modified Adcock antenna system is described in this paper. The method was introduced by the writer in 1938 to provide a simple and direct procedure whereby CAA personnel, especially those in the field, could pre-determine the correct adjustments of the radio equipment for producing the required courses. The extensive simultaneous equations necessary to secure these data in the past were presented in the initial installment.

Charts presented in this installment were referred to last month, under the ***Course Squeezing*** *heading. A condensation of these data are offered in this installment to facilitate the use of the charts.*

The smaller angle subtended by the bisecting lines is referred to chart 1 and the ratio of primary currents determined. The smaller current is for the goniometer primary having the same signal identification letter as the smaller quadrants.

The angle of bend for a pair of courses is the angle between either course and the corresponding bisecting line. The angle of bend for one pair of courses is referred to chart 2 and the bending effect, ***L****, thus determined.*

To adjust the relative output of the carrier and sidebands so that 30% modulation exists on the strongest course or courses, the power output of the carrier channel is first adjusted to the level designated for the desired coverage of the station. Then the sideband power is adjusted by setting the r-f current in the sideband tower T_1, when the goniometer is set on zero, in accordance with the ratio of currents obtained from chart 3 (identified as chart 4 in previous installment), after the values of L_G and angle A are determined by use of a graphical method as described and illustrated in Figure 4 (November, COMMUNICATIONS*).*

Chart 3 is used by drawing a line from the value of angle A on the right-hand scale through the frequency to the left-hand scale. At this intersection the value of L_G is added using the L_G scale. The ratio of current values opposite this point is the ratio to be used for adjusting the current in the sideband tower T_1 (when the goniometer is set on zero) with respect to the current in the center tower for 30% modulation of the range signals.

(See pages 53 and 56 for charts 2 and 3)

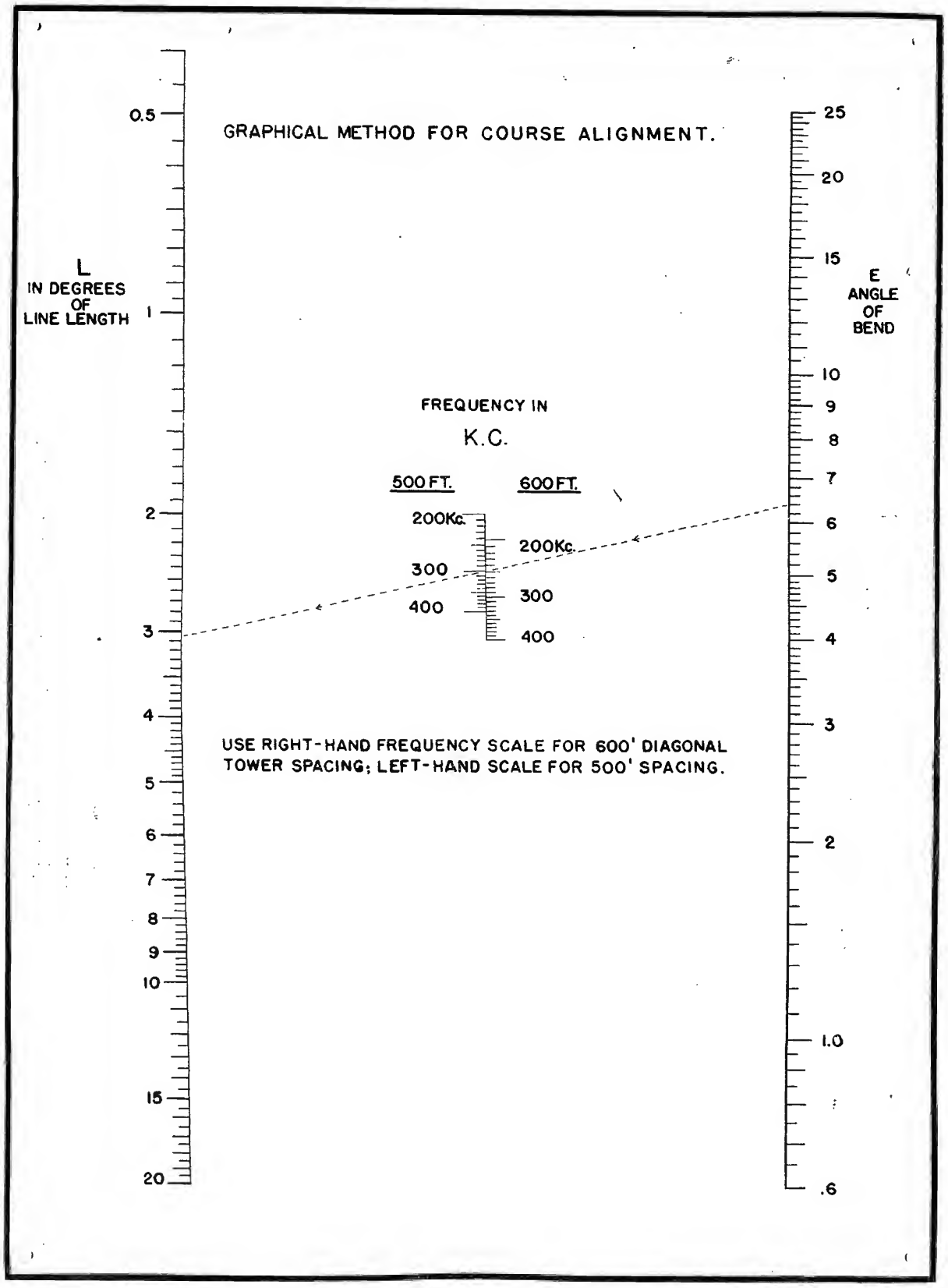

Chart 2 (Chart 3 appears on page 56)

COAXIAL CABLES

(*Continued from page* 35)

trical requirements, therefore, is seen to be no mean figure. Intensive studies on the structure of high polymers in relation to their physical properties, and the knowledge of what is required for electrical characteristics, have provided clues to the final answer.

It is now well established that high polymers, such as cellulose, polystyrene, lucite, polyethylene, polyvinyl chloride, nylon, etc., consist of long chains of atoms of different length and which are bound to each other by van der Waal's or secondary forces, or by what is known as the hydrogen bond. It is in the molecular configuration of these long chains that we find the explanation of why one plastic differs from another in physical properties. While the information in this field is still somewhat fragmentary, it is possible to make broad generalizations which have proven to be of inestimable value not only in understanding the basic physical reasons for the behavior of these materials, but in determining which way to proceed in the synthesis of new compounds.

The relationship between mechanical properties and average chain length of the molecule is such that there exists a critical minimum value of chain length before any mechanical strength is reached. This minimum value ranges between 40 to 80 units and is smallest in the case of nylon and longest in the case of hydrocarbons such as polyethylene and polystyrene. Once this minimum chain length has been reached, the material shows mechanical strength, and its ultimate properties are roughly in proportion to the average chain length, until an upper limit of chain units of about 250 is reached beyond which there is no appreciable change.

Summarizing the results of much work in this field the following would appear to be a reasonable explanation of the facts:

(*1*)—A typical plastic is characterized by a molecular structure wherein the forces between chains are moderate and the geometry of the chains such that crystallization (as deduced from x-ray examination) can generally occur. The exact nature of the material will be greatly influenced by external conditions such as temperature and pressure.

(*2*)—Fibres are found where the forces between the chains are strong and the structure of the chains such that they fit easily into a crystal lattice. This gives rise to high external crystallinity and the typical fibrous structure.

(*3*)—Rubbers are formed when the molecular attraction between chains is very small and the chains are so constructed that they fit badly into a crystal lattice. Under these conditions the material under stress always has a tendency to return to its original state.

It is, of course, obvious that these three groupings are not absolute, since they grade into one another, and by suitable mechanical treatment it is often possible to make a material from one of the groups fall into another category. A few typical examples of high polymers will demonstrate how this conception works out in practice.

Natural rubber is a polymeric isoprene. In its unstretched state it has an amorphous structure as shown by x-ray analysis, but if it is stretched to 200% or more it exhibits characteristic crystallinity. The presence of the methyl groups on the chain, situated as they are, prevent the close packing of the chains, and this coupled with the low molar cohesion gives this material its characteristic rubbery properties.

Polyethylene is an example of a very simple molecule, with a marked absence of side groupings. The molecules pack tightly together and the material exhibits a typical x-ray pattern. Thus polyethylene tends toward the fibre like structure and this is borne out by the ease with which filaments of this material can be made and the *cold-drawing* effect that is observed on stretching, coupled with the relatively sharp melting point exhibited by this material.

The synthetic rubber, *GR-S* or *Buna-S* is a good example of how these concepts or physical properties have been put to practical advantage. *GR-S* as is well known, is a copolymer of butadiene and styrene. Butadiene by itself has been polymerized, but the products obtained are not very well explored or identified. However, it would be expected that in a pure polybutadiene the chains would pack tightly together and that marked crystallinity would be observed. We would, therefore, expect the material to be somewhat similar to polyethylene only if anything, a little more of a true

(*Continued on page* 90)

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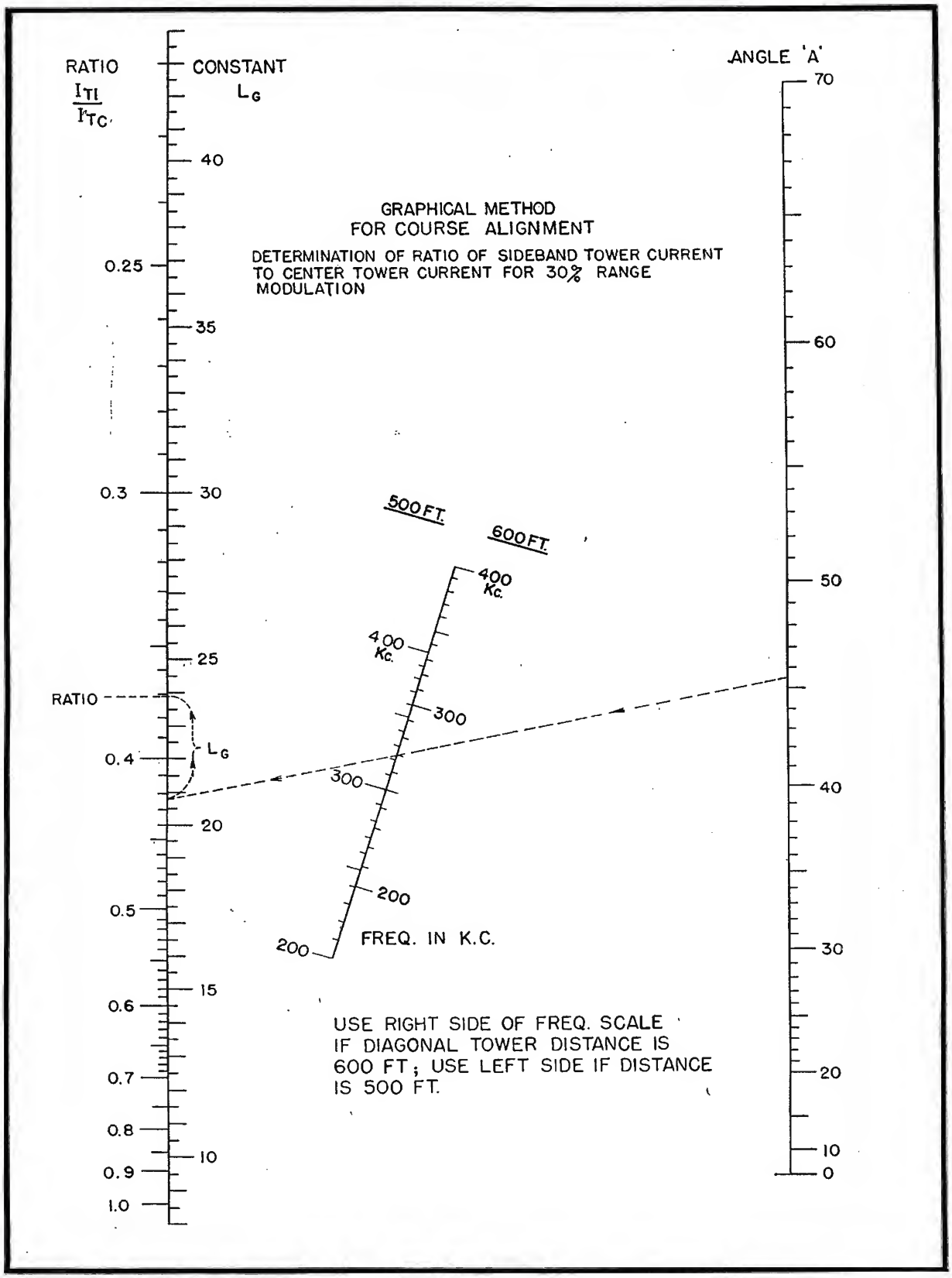


Chart 3 (Charts 1 and 2 appear on pages 52 and 53)

BETHANY 200-KW H-F TRANSMITTERS

by R. J. ROCKWELL

Director of Broadcast Eng.
The Crosley Corporation

[The initial installment of this paper, which appeared in November COMMUNICATIONS, covered the basic purposes of the transmitters, and pioneering steps in solving problems including selection of suitable sites, buildings and necessary materials. Many of the transmitting features were also analyzed. These included transmission and antenna systems, r-f generators, r-f drivers, final amplifier, plate tank circuit, audio and control room equipment, modulation, power supply substation and transformer vault. In this, the concluding installment, Mr. Rockwell discusses the high voltage supply filter, rectifier cabinet, carrier alarm, antenna switching, matching and operation.]

THE high-voltage supply filter consists of a .5/2 henry reactor, and 20 mfd. of 20,000-v condensers. Power from filter is distributed to other components in the vault on copper buses. All d-c power circuits to the r-f section have series surge-limiting resistors, and magnetically operated isolation switches, which are mounted on the vault walls. The 24-ohm surge-limiting resistor for the final amplifier is a bank of edgewise-wound resistors, mounted in a rack. For the lower voltage circuits, standard open-wound resistors are used. The isolation switches are standard 25,000-v 3-ampere single pole switches with arcing horns added to minimize burning of the contacts. The bias-power supply consists of a 7.5-kva transformer, with 2-10 henry 2.5-ampere chokes in the full-tap circuit. and a .5-ampere 10-henry choke in the half-tap circuit. With only the low voltage and bias supplies operating, the a-c power for the latter is fed through the 240-v breaker panel; but when the high voltage power supply is energized, the power is fed through a 7.5-kva step-down transformer from the secondary of the 750-kva plate transformer, which causes the bias voltage to vary directly in proportion to the changes in the high voltage supply. The low voltage supply uses a 5-kva transformer, and the same size filter chokes as the bias supply. The d-c power from the low voltage and bias supplies also incorporates a set of surge resistors and standard three-pole isolation switches.

All of the condensers used in the power supplies are equipped with a special fuse mechanism, which automatically disconnects a faulty condenser from the bank, and places a short across it.

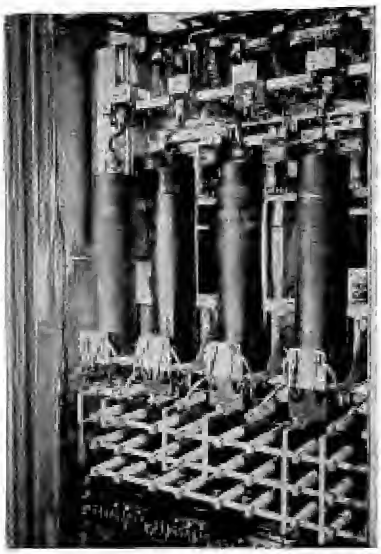
Rectifier Cabinet

The rectifier cabinet (Figure 17) contains three rectifiers, two of which are low voltage bridge circuits, one providing bias voltages of 2000 and 4000 v, and the other providing plate voltages of 1000 and 2000 v. The third rectifier is the high voltage six-phase single *Y* cir-

(*Continued on page* 60)

Figure 17
The rectifier cabinet.

Figure 18
Tube switching panel



(*Continued from page* 58)

cuit, employing six 870A tubes, and provides plate voltage for the modulator and final amplifier. Two spare 870 tubes are kept continuously heated, making a total of eight tubes, all of which are mounted on a thermostatically-controlled air duct, with nozzles blowing on their individual mercury radiators. This duct is supplied from a vertical duct in which are mounted strip heaters and their control switches, and which connects with the overhead cold air supply.

Below the tubes, at the rear of the cabinet, (Figure 18) is a tube switching panel, so arranged as to make switching of spare tubes into the circuit an error-proof procedure. Six of the eight tubes are always connected into the circuit by means of six jumper straps, in pairs of three different lengths, no two of which are identical due to the left or right twist of the top end of each strap. The upper switch jaws just below the tubes are mounted at corresponding angles, slanting alternately left and right, and connecting alternately to cathodes and anodes of all eight tubes.

When a fault occurs, the annunciator light on the front meter panel indicates which tube is defective, and it is necessary only to remove the corresponding jumper strap and insert it into the only vacant position into which it will fit. This arrangement provides one spare tube each for the parallel cathode side and the parallel anode side of the circuit. Below this switching panel are mounted the high-leakage reactance-type filament transformers for the 870 tubes, which automatically limit starting filament current.

Tube Cooling

The heat dissipation system consists of a separate blown-air and water cooling system for each transmitter. The fan and pumping equipment for each unit is housed in the fan room directly behind the unit. Each system is designed to dissipate 350 kw of electrical power, and provide for removal of waste heat in the transmitter cabinets and high velocity air for cooling the mercury radiators on the high voltage rectifier tubes, as well as cooling water to the ignitron units. The system is also arranged to furnish *by-product* ventilation of the building in summer, and heating of the building in winter. Auxiliary steam coils are installed in connection with the air units, to operate automatically when there is insufficient waste electrical heat for adequate building heating.

Each fan room is equipped with two double-inlet, double-width centrifugal fans, individually motor driven. The fan suction plenum is connected through dampers to a filtered outdoor air plenum, to the building concourse, and to a recirculated warm air bypass. The fans discharge the air through four, finned copper, distilled water cooling coils, from where the heated air is wasted to atmosphere or delivered to the building for recirculation. Forced air ventilation for the transmitter cabinets and ignitron cooling system is taken directly from the fan discharge plenum, which is maintained at constant pressure. An evaporative cooling section is provided for the ignitron unit, to supply water at lower temperature for this unit. The remainder of the system utilizes dry air cooling, to obviate maintenance of coil surfaces and attendant spray water nuisances.

Each transmitter is equipped with a separate distilled-water circulating system. The pump is of the horizontally split case type, direct connected to a 1750-rpm motor. The pump takes its suction from an open surge tank and discharges the water through the finned cooling coils previously mentioned. From here it goes to a distributing supply header below the transmitter cabinets, where it is fed through individual circuits to the various tube jackets and coils. The heated water is then collected in a similar supply header which carries it back to the surge tank, which serves as an air release and automatic make-up chamber. A similar system of much smaller capacity is used for the ignitron system.

Water is distilled in a 50-gallon-per-hour capacity still in the boiler room, and is pumped from there to a gravity tank in the tower, then to the various surge tanks. The still is operated by steam from the heating boilers.

A complete pneumatic control system operates the various dampers in the blown-air system, from a master panel housed in the main control center at the rear of each transmitter unit. Flow meters, pressure gauges and thermometers are conveniently located on the slanting front edge of the transmitter catwalk, so the operator can instantly determine the water flow and air and water temperature at critical points in each circuit.

Control Circuits

Since the complete transmitter unit is composed of two r-f sections, one power supply and one modulator, the control circuit had to be arranged to provide for individual or simultaneous operation of these sections. As it is set up, either r-f section can be operated as an individual transmitter, or both can be operated from the common power supply and modulator. In case of a fault or tube overload while both units are in operation, automatic isolation of the units is provided, to minimize loss of air time of the unit in operating condition.

The heart of the control system is located in the rectifier cabinet, and each function in the operation is initiated from the push button on the front control panel. The relay panel contains the primary-control relays plus the annunciator relays. On the meter panel at the top of the rectifier cabinet, a set of 50 annunciator lights indicate open transmitter or vault doors, and the operation of overload relays, each of which has an associated annunciator relay, which locks up after a fault occurs, lighting the corresponding annunciator light until a reset button is pushed. Another button closes all annunciator relays to test for burned out lights.

For checking faults in the control system, a series of 40 small 1/25-watt neon lights are provided on the annunciator relay chassis, each of which is connected across a particular set of overload relay contacts, door interlocks, or control relay contacts, so that in normal operation none of the lights would be lit; but, if a fault occurs, the neon light number, in conjunction with a chart, tells which circuit is open. In turn, each overload relay has a neon light across its contacts,

(*Continued on page* 66)

welding with a paint brush?

Alloy flows easily and weld is quickly completed under arc.

To solve a difficult welding problem, Eimac laboratory technicians compounded a welding alloy that could be applied with a paint brush. The alloy flows easily under an arc to complete the weld, yet subsequent heating to temperatures as high as 2900 degrees Centigrade will not destroy the weld.

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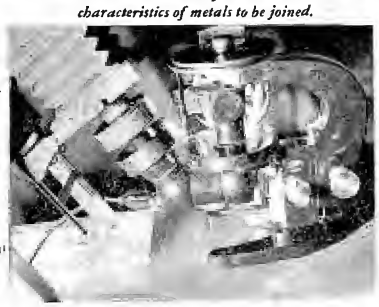

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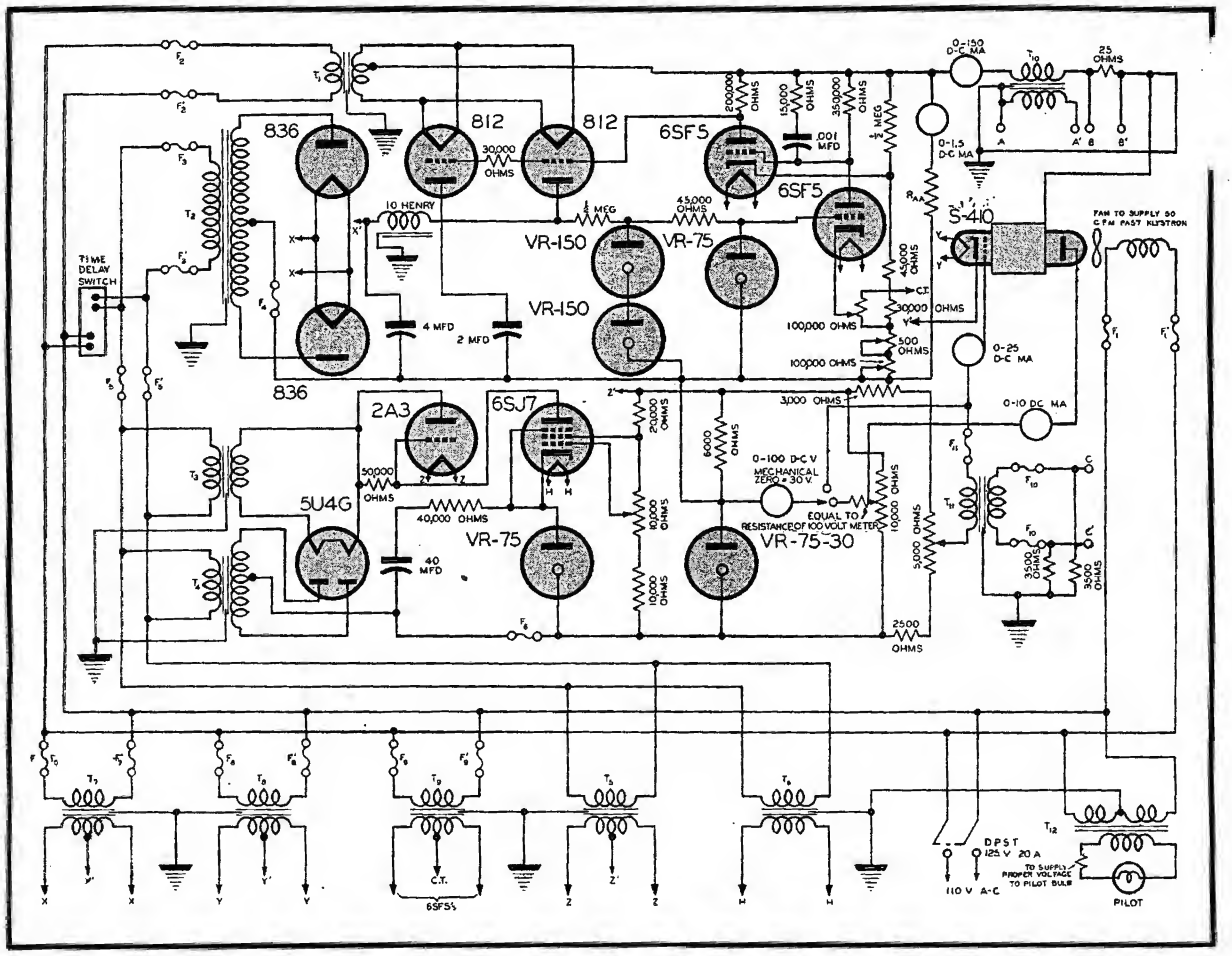
POWER SUPPLY FOR U-H-F VELOCITY-MODULATED TUBES

Power supply circuit for the klystron. R_{AA} are four selected resistors permitting the 0 to 1.5 ma meter to read 3000 volts d-c.



Transformer characteristics: T_1, 110-v to 6.3 at 10 amp, 5,000 volts insulation; T_2, 110-v to 1,500, each side of center at 250 ma; T_3, 110-v to 5.0 at 3 amp, 3,000 volts insulation; T_4, 110-v to 225, each side of center at 90 ma, 3,000 volts insulation; T_5, 110-v to 2.5 amp, 3,000 volts insulation; T_6, 110-v to 6.3 at 1.0 amp, 3,000 volts insulation; T_7, 110-v to 2.5 at 10 amp, insulated for 10,000 v; T_8, 110- to 6.3 at 5 amp, 3,000 volts insulation; T_9, 110-v to 6.3 at 2 amp, 3,000 volts insulation; T_{10}, modulation transformer (1:3), 1,000 volts insulation (secondary able to carry 200 ma without saturating); T_{11}, modulation transformer (1:1), 2,000 volts insulation; and T_{12}, 60-80 ma, 600 to 800 v c.t, (small power transformer h-v secondary connected to lines).

by IREDELL EACHUS, JR.

Formerly ESMT Communications Instructor, Moore School of Electrical Engineering, University of Pennsylvania; now on leave.

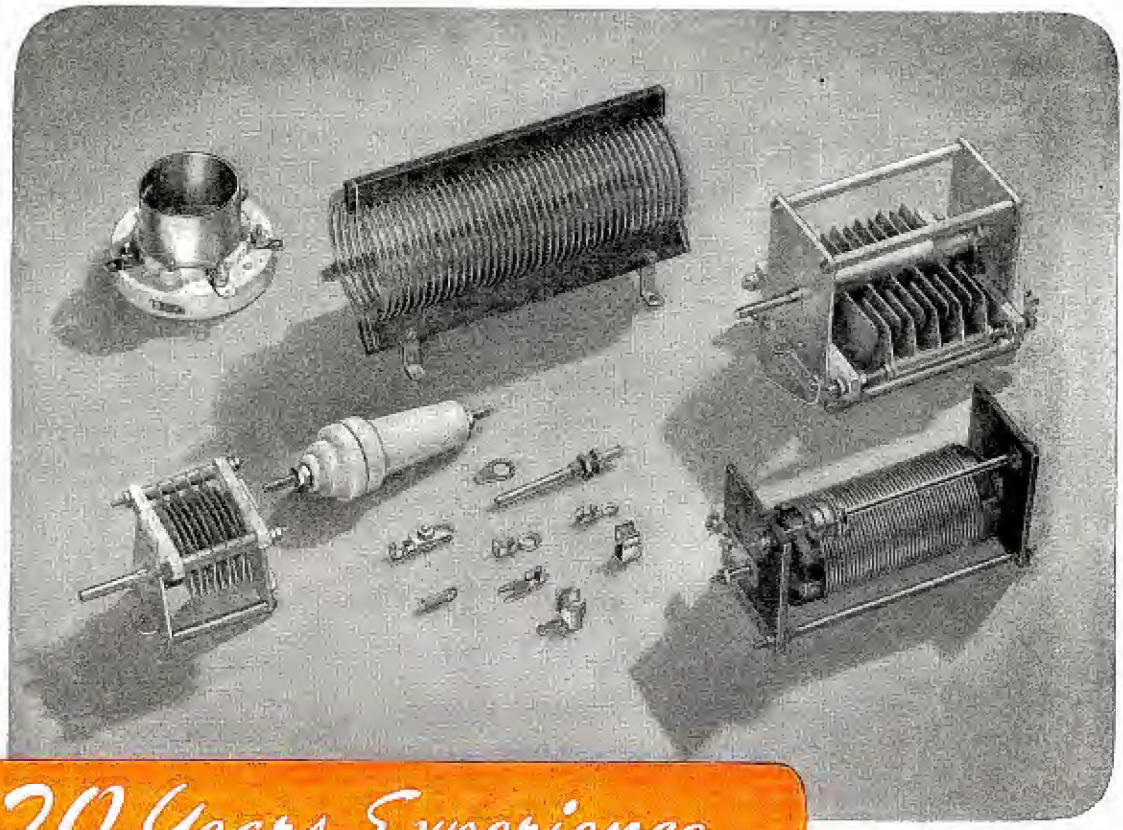
This paper is based on work carried on by the author at the Moore School

TO analyze critically the characteristics of the klystron, serving as a general purpose r-f source of approximately 3,000 mc in our laboratory, it was necessary to develop a special power supply. This unit had to be capable of operation with a minimum amount of instruction and operate continuously for a period of 4 to 6 hours, with reasonable stability as regards to frequency and amplitude for one-half hour or more.

To obtain the long range stability required it was necessary to regulate the fluctuations of line voltage and to prevent excessive heating of any part of the apparatus. The effect of temperature on resistors and on the dielectric in condensors is well known. There is in this case another place where the operating temperature is important. The primary frequency determining elements are the rhumbatrons. These are essentially small metal containers in which the electromagnetic waves oscillate in a natural mode of oscillation. The resonant frequency at which the natural oscillations occur is directly dependent upon the interior dimensions of the rhumbatrons. The rhumbatrons also serve

(*Continued on page 97*)

U-H-F LABORATORY RESEARCH



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TRANSMITTER DESIGN YESTERDAY AND TODAY

by DONALD McNICOL

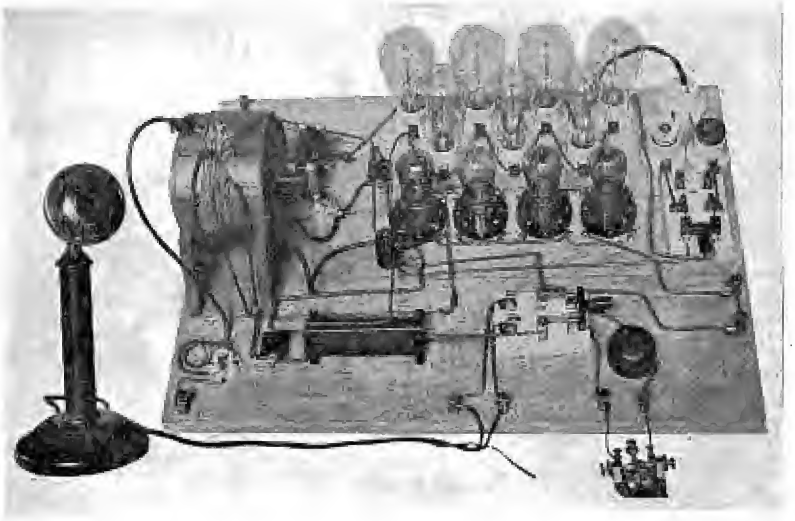

Figure 1

Phone transmitter of late 1920, assembled by New York experimenters. The dpdt switch provided for buzzer operation by Morse key for test or for telegraph.

INSPECTING the extensive electrical and mechanical equipment of a modern high-power radio broadcasting station, and giving the once-over to a 1944-vintage mobile radio station of the armed forces presents food for thought, particularly to radio engineers with memories. Young men, who prior to the war were not even remotely associated with radio are providing us with glowing accounts of what the radio communication men are accomplishing with present-day equipment, on the battlefields, where they fought. To the non-radio man the accomplishments border on the miraculous. Indeed, many of the young radio men at the front who learned all they know about radio within the past three or four years, are accomplishing miracles in the field. They view the equipment as something that has come out of the intense war effort in production of recent months, and in some degree this is true. To the host of radio engineers, however, still active, who can recall the steps in development of the equipment which have been taken in the course of the years, occurs a sobering thought. In sober thinking there is the impulse to contemplate what another quarter of a century of engineering development will do to the equipment of today. The inventive, the constructive engineer, the engineer with vision is not given to gloating over past or present accomplishments. Rather, in the main his thinking is along the line of what can be done, what must be done to provide extensions and betterments, above and beyond what is available today.

Engineers who ponder over the possibilities of advancement of an art, have the benefit of a yardstick, a measure, in what has been accomplished in a given period of time. Viewed in short periods of time, the curve of improvement progress may flatten occasionally before resuming the climb to the upper right-hand corner of the sheet. But when the base line covers a period of twenty to twenty-five years, what has taken place through the years stands out in bold relief.

It is the purpose in this paper to mark only one of the milestones in the progress of radiophone development. However for the sake of perspective it might be recorded that in association with the late Charles V. Logwood, in 1908, in the West, we constructed for demonstration purposes a model of Collins' radiophone transmitter, the type exhibited by Collins at Madison Square Garden, New York, in that year. It was necessary to make up an arc generator patterned after

(*Continued on page* 89)

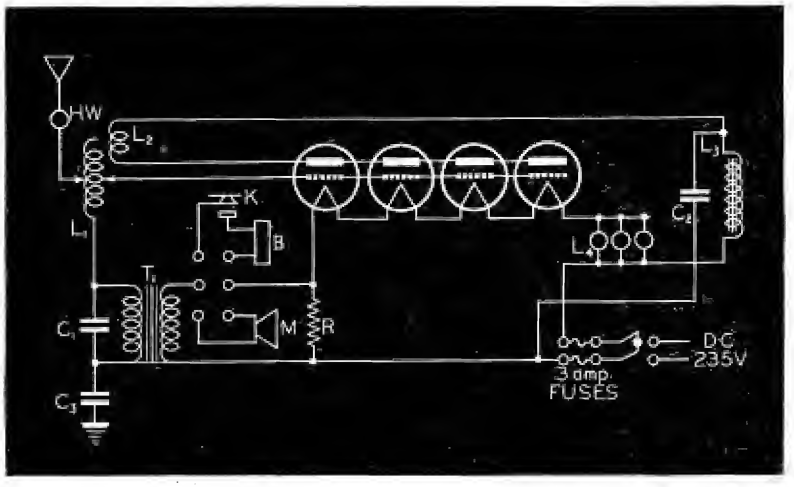

Figure 2

Circuit of transmitter shown in Figure 1. L_1: antenna grid inductance (5½" tube, with 13 turns of No. 18 dcc or annunciator wire, tapped each turn). L_2: plate inductance (5" tube, with 14 turns of No. 18 wire, tapped each alternate turn). L_3: iron core, 1-henry choke coil. C_1 and C_2: r-f bypass .003-mfd condensers, mica insulated, to carry the power voltage applied. C_3: 2-mfd condenser to ground. T_1: Telephone transformer (one employed was a W.E. 5A). K: Morse key. B: buzzer. M: microphone (one type used was W.E. 284W). R: n-i resistance .60 ohm, to carry 2.5 amperes. L_4: Incandescent lamps, in bank, to permit flow of 2.4 amperes through the four UV 202 filaments in series. HW: hot-wire ammeter.

200-KW TRANSMITTERS

(*Continued from page 60*)

so the exact location of the trouble can be determined quickly.

This same equipment is duplicated in a dummy rectifier cabinet in the companion transmitter on the opposite side of the concourse, both operating with a common power supply and modulator.

All overload and arc-back relays, with the exception of the high-current delayed a-c overloads, are d-c telephone type relays, with special coil and contact insulation. The coil of the relay is in series with a current adjusting rheostat, and this combination is shunted by another resistance of the proper value for the protected circuit. This is a very flexible and satisfactory means of overload protection. Because of high operating speed, this type of relay gives better protection than the standard overload device. In cases where the coil must be at a high potential to ground, such as for arc-back protection of the rectifier tubes, the contacts are removed from the frame, and operated by an insulating rod.

All 240-v power is fed through a breaker panel in the wall cabinet behind the transmitters, and then through contactors which are operated by relays of the control circuit.

Filament Control

Conventional water flow and water temperature protection are provided in the filament circuits. Distilled water pumps, fans and filaments are controlled by the first pair of push buttons on the panel. A time delay provision is incorporated, to continue operation of pumps and fans until 15 minutes after filament shutdown. In addition, filament switches are provided for individual water-cooled tubes or banks of tubes, (depending on number of tubes in series on one water circuit), which permit changing of tubes without turning off all tube filaments. These switches control the primary power contactor, and short out the water flow interlocks associated with each particular tube or bank of tubes. The circuit is so arranged that turning on the filaments of the separate r-f section also turns on the filaments of the main transmitter, since the modulator and rectifier are needed for its operation. Conversely, turning off the filaments of the main transmitter turns off the filaments of both units.

Low Voltage and Bias Control

The second pair of push buttons provide control for the low voltage and bias systems. The interlock system is divided into three sections, one of which contains the door interlock switches of the rectifier, modulator, catwalk and transformer vault, and the overload relays contacts associated with these units. In series with this are the interlocks and overload relay contacts for each of the r-f sections. An emergency *off* push button is located in the center of the control panel of each cabinet. These are also in series with the interlocks. Magnetically controlled isolation switches are used to remove the d-c voltage from an r-f section when not in use, or if a failure in one should occur while both are on the air. These switches are designed to break circuits with the power on. The a-c power for the

bias supply is fed through the same contactor that supplies the low voltage power, when the low and bias voltage supplies are first turned on. However, when high voltage is turned on, the bias power is obtained as described in the discussion of the transformer vault.

Bias switching is accomplished with a fast-operating reversing contactor, mechanically interlocked to prevent an interconnection of the power sources.

High Voltage Controls

An unusual feature of this system is the anti-pumping circuit. Should a fault occur while the *on* push button is held down, the power supply interrupter has only one closure, and will not reclose until the button is released and pushed again.

D-c voltage to both the r-f driver and final amplifier is fed through individual magnetically operated high-voltage isolation switches. The control of these switches is arranged to operate only when the d-c voltage is off. Thus, if one r-f section is turned on while the other is operating, the power supply shuts down long enough for switching to take place, then automatically comes on again. The same occurs if one of the units is turned off, or if an overload occurs in either section. To facilitate neutralizing of the final amplifier, a switch is provided on the relay panel of this cabinet for individual control of the isolation switch, thus removing high voltage from the unit, and permitting it to be applied to all other units.

The Ignitron

Another novel feature of this installation is the use of the ignitron as the 2300-v high-speed circuit breaker. The overload-relays protecting equipment connected with the high voltage supply have one set of contacts in a conventional interlock circuit, which serves to remove power supplying the thyratrons which ignite the ignitrons. A second set serves to bias the thyratrons in advance of removing power, so that if an overload occurs, there is an almost instantaneous interruption of power; many times faster than with conventional a-c relays. The control system is, of course, tripped by the first set of contacts when a fault occurs, and interrupts the control voltage for the ignitron. Thus, two means have been included to insure shutdown of the high voltage supply, making a high-speed circuit that operates in 3 to 10 milliseconds after the overload relay operates, depending on the portion of the cycle the ignitron is passing at the time. The average time of the telephone-type overload relays used is about 5 milliseconds. Thus the overall time for interruption of power is only a fraction of that required for the conventional overload relay and air- or oil-circuit breaker.

The high-voltage tap changer remote rheostat, with its associated torque switch and front panel control, as previously explained, is duplicated in the dummy cabinet on the opposite side of the concourse. Associated with this control on both main and dummy rectifier cabinets is a push-button to switch the tap changer

(*Continued on page* 70)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

Personals

FROM the Pacific area, we've received a letter from a VWOA member that bristles with news. It's from Lt. Commander V. H. C. Eberlin, Air Communications officer for Admiral Sample. Commander Eberlin says:

"It matters not where you are in the restless Pacific, sooner or later COMMUNICATIONS catches up with you. It is certainly a pleasure to have this medium of learning where and what some of the other members are doing. . . . Especially so since we have during the past few months been covering the waterfront from Tokyo's front door to the Phillipines, lending a helping hand to setting the rising sun.

"Our last endeavor was in the battle of Samar Island, off the mouth of the Gulf of Leyte. We had just finished supporting the Leyte Island landing a few days previous, when ole man Nip slipped an end run on our gallant group. They came in running with everything blazing and for hours it appeared like they might make a touchdown. Our team took everything they had, and it was plenty, but the old forward pass finally turned the tide and those that were left limped home through a blaze of fire.

"Tokyo Rose can now brag about having the largest underwater fleet of all time. The figures may seem fantastic, but they're true.

"You can issue a charter for the Philippines chapter of the VWOA; we've just finished the groundwork and laid the cornerstone.

"Hello to the gang from your Far Eastern representative."

LIEUTENANT George Bonadio of the United States Navy reported some interesting experiences in the present war as 44th Division Radio Officer, Amphibious Force Pacific Fleet Radio Officer (including the Japanese code) and as Fifth Army Headquarters Radio Officer (Army-Navy Communication Liaison Officer). . . . From Hugo L. Estberg we learn that he started as a ship radio officer during the last war with RCA

Brigadier-General David Sarnoff, who has just returned from overseas duty.

•

and served for some time at WNY in New York. From 1923 until the present he has been identified with merchandising and servicing. . . . It was grand to see Charles G. Cooke at the recent Fall meeting. Mr. Cooke was one of the earliest radiomen in the United States Navy starting in November 1903. He served aboard the USS Prairie, USS Illinois, and operated at the Portsmouth Navy Yard in 1907. At present he is with Du Mont.

•

Merit

BRIG. GENERAL David Sarnoff, number 1 life member of VWOA, recently returned to the Office of Chief Signal Officer in Washington, after almost a year's service as special consultant on communications matters in the office of the Allied Supreme Command in London. In recognition of his outstanding accomplishments Gen. Sarnoff was awarded the Legion of Merit.

Our sincere congratulations, General Sarnoff on your splendid achievements. General Sarnoff received our Association's Marconi Memorial Medal of Achievement, a few years ago.

•

In Memoriam

ON March 4, 1942, Louis Crowley, received a telegram disclosing the urgent need for seagoing operators. He was then at RCA Communications. He flew from New York to Texas and sailed on March 5th (the next day) aboard the SS Swiftsure. The boat dropped anchor at South Africa, Iran, Iraq, Arabia, India, Australia and back to the middle East. On the night of October 8, 1942, enroute back to the U. S., the Swiftsure was torpedoed off the East coast of Africa. The vessel was lost, but most of the men managed to get into lifeboats and three days later landed at Capetown.

A few weeks later Radio Officer Crowley, together with some two hundred other repatriates, sailed aboard the MV Zandam.

On November 2, 1942, the Zandam was torpedoed and sunk about five hundred miles off the coast of Brazil. Only three lifeboats reached land. Radio Officer Crowley was reported seen aboard a life raft. But eighty-three days later only three crewmen of the Zandam were picked up off a liferaft. They were unable to give information as to any other survivors . . . two hundred had been lost.

The VWOA and members of the industry mourn the loss of a brave man . . . Louis Crowley. The United States Maritime Commission has notified Mrs. Crowley that she will be presented the Mariner's Medal. This to be added to Radio Officer Crowley's three area ribbons and one combat ribbon with two stars.

•

20th Anniversary

THE Veteran Wireless Operators Association will celebrate its twentieth anniversary with a Victory Dinner-Cruise on the Belvedere Roof of the Hotel Astor, New York City on Saturday evening, February 17, 1945. Be sure to send in your reservation at the earliest possible moment!

•

Boston

THE Navy Radio Training personnel of the Massachusetts Radio and Telegraph School recently tendered a testimonial dinner to the founder of our Boston chapter, Guy Entwistle. Guy was presented with a suitably inscribed scroll. Congratulations, Guy. You have always done a grand job for VWOA, too!

200-KW TRANSMITTERS

(*Continued from page 67*)

control circuits from one rheostat to the other.

Automatic Reset

The fourth pair of push buttons on the control panel operate the automatic recloser circuit. When *on*, this circuit automatically reenergizes the power supply after an overload occurs. Should a second overload occur, or the first fault still exist, within fifteen seconds, that particular r-f section in which the fault took place is isolated and the remainder of the transmitter turned on again. If no further trouble develops within that fifteen-second period, the system resets itself and is ready to operate again.

Carrier Alarm

A relay in the cathode circuit of one of the final power amplifier tubes operates the carrier-alarm system. This relay is set so that it will pull in under normal operating conditions, but drop out if excitation or plate voltage should fail. And in conjunction with another relay, it operates the alarm, a warning light above each transmitter, and a horn common to all six final amplifiers. If a transmitter goes off the air, the carrier alarm can be switched off temporarily, but becomes effective each time the transmitter is turned on.

Personnel Protection

For the safety of personnel, all equip-

●

Figure 19

Elements composing the antenna switch. They are the same diameter and spacing as pipe conductors connected to switch.

●

ment operating at high voltage is completely enclosed and interlocked. Each transmitter cabinet has a solenoid-operated shorting mechanism which grounds all high voltage terminals in the cabinet when any cabinet door is opened. This is located in the upper part of the cabinet where it is easily visible from both front and rear. Catwalk grills and doors are interlocked to operate the shorting mechanism in the rectifier cabinet.

The high voltage components in the transformer vault are enclosed with wire fencing. Before this section of the vault can be entered, a lever must be thrown which operates disconnect and grounding switches, and a mechanical interlock on the cage and ignitron doors.

Transmission Lines

The transmission lines from the transmitters to the main antenna switching station are all of 300-ohm surge impedance. The section leading out of the building is of 2" copper pipe, in order to be self-supporting across 18' driveway clearance, and to present good corona conditions through the glass entrance pane. These pipes are spaced 13". From this point to the main switching station, the line consists of a 4-wire construction, using two pairs of 1/0 copper weld (each pair as one conductor), spaced 2⅛" one above the other, and 7" between pairs, which is the same spacing as used in the 300-ohm switch structure, where two 1" copper pipes are used for each line. To maintain spacing between wires on each side of the line, cast clamps are used at intervals of about 10'.

Antenna Switching Station

To meet the requirements of multiple switching of antennas and transmitters at 200-kw powers, the following specifications had to be met in the design of the main antenna switching station:

(*1*)—Provision for connecting any transmitter transmission line to any antenna transmission line.

(*2*)—Provision for unlimited expansion of number of transmitter and antenna transmission lines.

(*3*)—Maintenance of 300-ohm im-

(*Continued on page 72*)

Figure 20
A view of one of the transmitter vaults.

(*Continued from page 71*)

pedance throughout, regardless of switching operations.

(*4*)—Elimination of all dead-end effects.

(*5*)—Provision for breaking up all unused lines to prevent possibility of resonance.

(*6*)—Simplicity of operation and identification for scheduled switching.

These requirements were met by designing a structure carrying incoming transmitter transmission lines on a lower level, and outgoing antenna transmission lines on a higher level, at right angles with the incoming lines. Between these two levels are vertical spiral riser lines, terminating top and bottom with double-pole, double-throw switches. On short posts near the ground are operating cranks, which operate the switches through mechanical linkage.

Electrically, all lines continue through the structure as long as all switches are in horizontal position. Operation of a lower switch breaks the line at that point, and connects the transmitter with its vertical riser. Operation of the associated upper switch breaks the antenna line at this point and connects the antenna to the riser, thus completing the circuit from transmitter to antenna. No unused lines remain connected to the system to cause dead end effects. The unused lines which have been disconnected may be further broken up into shorter sections, if desired, by operating other switches beyond the point where the connection was made, in order to prevent any possible resonant effect.

As seen in Figure 19, the elements composing the switch are of the same diameter and spacing as the pipe conductors connected to the switch, providing constant impedance throughout the structure.

No limitations are imposed on possible future expansion, since it is necessary only to add more lines and switches as transmitters or antennas are added.

Matching Sections

Immediately upon leaving the main antenna-switching station, impedance matching sections are inserted between the 300-ohm gear and the 500-ohm antenna transmission lines. These sections comprise 3 lines, each one-quarter wave long in tandem, varied in spacing and

Figure 21

An interior view of the antenna service car. Equipment in this car includes two-way f-m communications equipment, affording constant contact with the control room.

conductor size to accomplish the transition. Two types are used: type *A* sections have a design frequency of 12.3 mc, and are connected to lines serving both large and small antennas requiring maximum frequency range of 6 to 18 mc; type *B* sections are designed at 13 mc, and are used in connection with lines serving antennas operated between 7.5 and 15.5 mc.

Transmission lines of 500 ohms from these impedance matching sections to the antennas are, in some cases, as long as 3750′. To keep loss at a minimum consistent with cost and use of critical materials, 4-wire construction was used, consisting of two pairs of number 2 copper weld wire, each pair spaced ¾″ as one conductor, with 20″ spacing between pairs, and with all four wires in the same horizontal plane. As in the case of the lines leading from the transmitter building, clamps maintain the ¾″ spacing.

Lines run at about 15′ above ground in most places. Turns are accomplished by vertical spiralled jumpers to maintain equal conductor length and spacing. Where more than one transmission line is carried by the same pole line, a spacing of better than four times the 20″ conductor spacing is maintained, to keep coupling at a reasonable minimum.

Line Switches

The 24 antennas are arranged in 9 groups, 6 of these containing 3 antennas each, the other 3 containing only 2 each. Each group is fed by a pair of transmission lines. In the case of the two-antenna groups, lines run directly from the switching station to the antennas; but in each of the 6 triple-antenna groups, one transmission line runs from the switching station to the middle antenna, while the other is arranged to be switched between the small and the large antennas, since these two are never used simultaneously. A special double-pole, double-throw switch is located along the transmission line near the antennas, so constructed as to have 500-ohm surge impedance. Thus no disturbance is introduced into the transmission system. The switch itself is located at transmission line level, and is operated through a mechanical linkage system, by a lever at waist height.

Reentrant Rhombic Antennas

Because of relative ease and low cost of construction, amount of critical material required, and satisfactory performance over a rather wide frequency range, rhombic type antennas are used for the 24 radiators. Three sizes cover the frequency range of 6 to 18 mc, with adja-

(*Continued on page* 74)

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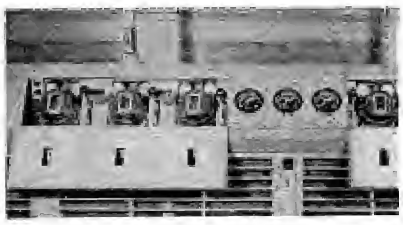
Figure 22
Water controls on front ledge of transmitter catwalk.



(*Continued from page 73*)

cent size pairs being used simultaneously.

These three sizes are designed at midfrequencies of 16.33 mc, 11.67 mc, and 9.33 mc, with a low vertical angle of approximately 10° and a beam width of 20° at these frequencies. Antennas are four wavelengths long on each side, with a tilt angle of 70°, and an average elevation of 1.4 wavelengths above ground. They are constructed of three number 6 copper weld wires on each side, spaced at the side poles, and converging to a point at each end. Due to low inherent coupling between adjacent rhombic antennas, common support poles were used between antennas. Each pole is actually two poles, spliced butt-to-butt with a steel sleeve. Poles rest in a 6" recess in a concrete base, and are guyed at three points.

In order to avoid wasting up to 50% of the power delivered to the antenna, by the conventional dissipative rhombic termination method, reentrant transmission lines have been incorporated, whereby the normally dissipated power is returned to the input line, properly phased and adjusted as to voltage magnitude, through the use of stub lines of the proper values and spacings along the return line. Impedance of the input line is corrected in a like manner, and in some cases combined with one of the reentrant stub lines. All stubs of the shorted variety are grounded at the midpoint of the short, to provide static drain, and lightning protection.

Operation

Transmitters are scheduled in pairs, so that, as one frequency is becoming less effective in a chosen coverage area, the other is already in operation on the frequency next coming into maximum effectiveness.

To change frequency, two men are required to make the necessary technical adjustments in the short period allowed (usually 15 minutes). One man retunes the transmitter, and the other makes the necessary antenna changes and adjustments. The control operator shuts down the transmitter after the scheduled sign-off, and disconnects the frequency generator which had been driving the transmitter, connecting it to the proper generator to supply the new frequency. This change is made on the r-f generator

patching panel. Then he moves the dials on the transmitter unit to pre-determined settings, or changes pre-tuned coil condenser circuits as required for each stage of the transmitter, beginning with the lower power stages, and ending with the high power final stage and the adjustable antenna coupling loop.

While these adjustments are being made at the transmitter, the second man proceeds, in an antenna-service car, to the main switching station, where he connects the proper transmitter transmission line with the proper antenna transmission line. Then he proceeds to the antenna group, and connects the transmission line to the desired antennas through the line switches previously described. Finally, the proper stubs are inserted by use of switches, to adjust the antenna for its assigned operating frequency.

Upon completion of the necessary adjustments, he advises the transmitter operator, who is then ready to put the transmitter on the air on its new frequency.

Antenna Service Car

The car which is used for these operations is especially designed and equipped for antenna work. Its equipment includes a complete two-way f-m communications set, with which the technician is in constant communication with the control room.

The f-m receiver is just one part of the complete *intercom* system, which also includes telephones and public address systems. The combination of the three affords a complete and flexible means of communication between personnel anywhere on the property.

The public address system employs permanent-magnet speakers which serve both as speakers and microphones. These are located throughout the building and at the main antenna switching station at the rear of the building. On the concourse, speakers are conccaled above the transmitter units, with a switch key on the hand rail. At each of these positions, a key is also provided to mute the monitor to prevent interference with the public address speakers. When one of the concourse speakers is used as a microphone, the other five are silenced automatically by a relay, to avoid feed-back. The same system is used at the switching station, where there are six speakers.

The f-m system is tied into the public address system in such a way that any calls picked up on the receiver are fed directly into the public address line. Through relay control, the f-m transmitter may be operated from the public address station at the control desk. The f-m system is used to maintain contact with the operator of the antenna service car, and with maintenance crews in the field.

Acknowledgments

The inception and realization of this project was made possible largely through the confidence, cooperation and active assistance of J. D. Shouse, vice president in charge of broadcasting, The Crosley Corporation; J. O. Weldon, chief of the Communication Facilities Bureau, OWI; and E. J. Boos, business manager, broadcast division, The Crosley Corporation.

It would also not have been possible to complete an undertaking of this size without the untiring efforts and close co-

(*Continued on page 76*)

(*Continued from page 75*)

operation of the entire broadcast engineering staff, as well as outside engineering organizations, who contributed materially to the project, in spite of facilities already overloaded with war contracts.

Acknowledgment is hereby gratefully extended to the engineering staff, particularly:

W. S. Alberts, chief propagation engineer
J. A. Baysore, supervisor, antenna construction
L. G. Bertenshaw, purchaser and expediter
C. C. Bopp, design and development engineer
D. H. Ehlman, supervisor, machine shop
J. L. Hollis, chief design engineer
E. F. Jenkins, equipment test engineer
P. J. Konkle, chief management engineer
F. N. Lantzer, chief transmitter engineer
H. Lepple, design and development engineer
J. M. McDonald, assistant engineering director
W. A. Moore, chief design draftsman
W. B. Nester, design draftsman
C. A. Robson, design draftsman
R. L. Schenck, design and development engineer
C. B. Sloan, design and development engineer
R. H. Uphaus, design and development engineer
P. A. Young, propagation engineer

The outside engineering organizations participating in the project included:

Federal Telephone and Radio Corporation; high-power vacuum tube develments
General Electric Company; ignitron equipment
The Cincinnati Gas and Electric Company; substation and primary power design, antenna mechanical design
The E. A. Gast Engineering Company; civil engineering and surveying
O. W. Motz, consulting engineer; vacuum tube cooling, building heating and ventilating design
C. W. Sinnege; building design and architectural engineering.

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Figure 23
Rhombic antenna, showing reentrant feature and stub-tuning arrangement.

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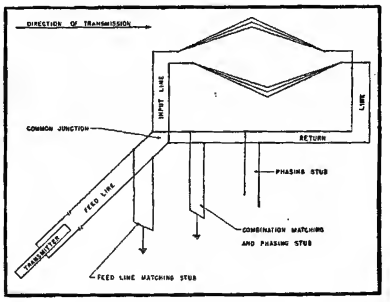

NEWS BRIEFS

CVILIAN-MILITARY NEEDS WILL KEEP TUBE QUOTAS HIGH AFTER V-E DAY

Combined military and civilian requirements for receiving tubes will be about 60 to 70 per cent above present maximum production rates after Germany's defeat, Government officials told the Radio Receiver Vacuum Tube Industry Advisory Committee recently.

Committee members said their ability to meet these requirements will be almost wholly dependent upon an increase of manpower in the industry. Cutbacks occurring in other industries should substantially increase the supply of labor available for radio tube production, they said.

Military requirements for receiving tubes now average approximately 10,000,000 tubes a month. The end of the European war will reduce military requirements slightly, but not until one year after Germany's defeat is a 45 per cent cut in such requirements expected, WPB officials said.

At present, approximately 13 per cent of total radio receiver tube production is available to civilians for replacement purposes only.

A report issued by the WPB recently stated that scarcely half enough radio receiving tubes have been available during the last two years to replace those worn out in civilian sets.

The civilian replacement tube shortage was due to increased military demand from 16 per cent of the total production in 1941 to 65 per cent the next year, 82 per cent in 1943, and 86 per cent in 1944. Labor is in short supply, but sufficient facilities and materials are available so that if 6,000 more female workers could be obtained, production of receiving tubes both for military and civilian programs could be stepped up, allowing an increase in civilian replacement tubes up to 4,000,000 a month, according to WPB.

During 1944, replacement tubes available to civilians cannot exceed 19,000,000, as against demands exceeding 36,000,000, the division said. The 19,000,000 tubes should enable home owners to maintain at least one radio receiver in operation, WPB said.

The present schedule for the production of civilian receiving tubes in the first quarter of 1945 is set tentatively at about 2,000,000 a month, an increase of about 500,000 tubes a month over past WPB authorization. However, the estimated monthly production can be attained only if increased labor is obtained and military demands do not increase, WPB said. If conditions are anticipated correctly, it is hoped that civilian tubes may be produced at the rate of 4,000,000 a month within about four months after V-E day.

Total employment in radio receiving tube plants was only 15,000 in 1941, but has increased to 39,000 today.

Under the conditions imposed by military demands, receiving tubes available for the public's use dropped gradually from 30,000,000 in 1941 to present renewal shipments of 19,000,000 tubes a year.

Army and Navy tubes that are not actually

(*Continued on page 78*)

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TELEVISION RELAY

A v-h-f transmitter and antenna on roof of Pol Grounds relaying television pickup of Army-Duke game to WNBT atop Empire State tower.

NEWS BRIEFS

(*Continued from page 77*)

needed are being channeled back to the original manufacturers through the Defense Supplies Corporation for redistribution, first for other other war requirements as they may occur and then to civilians.

* * *

RCA HOLDS 25TH ANNIVERSARY DINNER

A twenty-fifth anniversary dinner of the Radio Corporation of America was held recently at the Waldorf-Astoria, in N. Y. City. A highlight of the dinner was a message from President Roosevelt. Speakers included Major General H. C. Ingles, Chief Signal Officer, United States Army; Rear Admiral Joseph R. Redman, Director of Naval Communications, and Brig. Gen. David Sarnoff, president of RCA. Among guests at the speakers' table were Owen D. Young, founder and first chairman of the board of RCA; Edward J. Nally, the first president of RCA; Will Hays, president of the Motion Picture Producers and Distributors of America, Inc.; Major General James A. Code, Assistant Chief Signal Officer, and Brig. Gen. Frank E. Stoner, Chief of the Army Communications Service.

Participating in special program were Arturo Toscanini, Dr. Frank Black, Gladys Swarthout, Lauritz Melchoir, Hildegarde, the Bernard Brothers and members of the NBC Summer Symphony. Dr. James Rowland Angell, public service counsellor of the National Broadcasting Company, served as toastmaster, and Lowell Thomas was master of ceremonies.

Gen. Sarnoff, who returned recently after eight months of military service overseas, as special consultant on communications to SHAEF, declared that America's entire radio industry deserved high praise for record-breaking achievements in supplying the fighting forces of the United Nations with the finest radio-electronic instruments of war.

Gen. Sarnoff announced that the board of director approved a retirement plan providing pensions for life, for service prior to December 1, 1944, and life annuities for RCA employees based on equal contributions from the employees and the company after that date.

* * *

MOTOROLA APPOINTS WAVERING AND STELLNER VICE PRESIDENTS

Elmer H. Wavering has been named vice-president in charge of the new automotive division of Motorola radio, and Walter H. Stellner is now vice-president in charge of the new Motorola home products division.

Mr. Wavering joined Motorola as an engineer in 1930, and pioneered the design and engineering development of the first commercial car radio receiver during that year.

* * *

PACENT, JR., JOINS EMERSON RADIO

Louis G. Pacent, Jr., has been named head of the industrial engineering department of the Emerson Radio and Phonograph Corporation. Mr. Pacent holds degrees in industrial management from Columbia. He is the son of Louis G. Pacent, president of the Pacent Engineering Corporation.

* * *

RECHARGEABLE BATTERY FOLDER

A six-page bulletin on the recently introduced rechargeable wet-storage battery for flashlights has just been published by The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.

The catalog section outlines the development of the rechargeable wet storage battery built on the same principle as the automobile storage battery.

Featured are data on charging units sold with the battery. These range from a single unit to 12-unit gang chargers. Testers are also described and testing methods outlined.

* * *

A. T. & T. PROMOTES WILSON

Leroy A. Wilson has been elected vice president of the American Telephone and Telegraph Company, in charge of business research and Bell System revenue requirements studies.

Mr. Wilson was previously assistant vice president of A. T. & T. in charge of the commercial division.

* * *

METAL HOSE BULLETIN

A 12-page pamphlet, "Flexible Metal Hose for Every Industrial Use," has been released by the Chicago Metal Hose Corporation, Maywood, Ill.

The basic types of flexible metal hose available and some of their specifications, are presented.

* * *

U. S. AND INDIA NOW HAVE DIRECT RADIO-TELEGRAPH SERVICE

Direct radio-telegraph service between New York and Bombay, India, 8,000 miles around the globe, was introduced recently by R.C.A. Communications, Inc., 66 Broad Street, New York City.

* * *

SHERMAN WAR MATERIAL PACKAGING MANUAL

A revised manual on the protection of war materials has been issued by Sherman Paper Products Corporation, Newton Upper Falls, Massachusetts. In it are included digests of government specifications, with an expanded section on the protection of metal products. Included, too, is a cushion-wrapping method, also illustrated photographically in step-by-step sequence; 25 new photographs have been added.

* * *

THOMPSON, BELOUNGY AND BOWMAN PROMOTED BY CBS

Robert G. Thompson, CBS, New York, James J. Beloungy, CBS, Chicago, and Lester H. Bowman, CBS, Los Angeles, who supervise network technical operations in their areas, have been designated as managers of technical operations, Eastern, Central, and Western Divisions, respectively.

Thompson has been with the network since

WALKIE-TALKIE INTERVIEW

Carole Landis being interviewed via a walkie-talkie by Chicago *Daily News* editors who are at their office. Jerry Thorp, reporter, carried the equipment. John Payne and George Jessel are at right.

PART III OF WRIGHT PAPER ON RESISTIVE NETWORKS TO APPEAR IN JANUARY

The third part of the Paul B. Wright paper on *Resistive Attenuator, Pad, and Network Theory and Design,* scheduled to appear in this issue, will appear in the January issue.

September, 1929, when he joined as a field operator in the technical department.

Beloungy joined CBS in January, 1934, as chief engineer of WPG, Atlantic City, N. J.

Bowman came to the network in March, 1929, as a supervisor in technical operations at WABC.

Dr. Peter C. Goldmark, and William B. Lodge have also won CBS promotions. Dr. Goldmark is now director of engineering research and development.

William B. Lodge has been named director of general engineering.

Technical operations in the fields of standard broadcasting, f-m and short-wave broadcasting will continue under the direction of Henry Grossman, director of technical operations, and under the general supervision of James M. Seward, the network's director of operations.

* * *

LEWYT POSTWAR PLANS

Lewyt Corporation of Brooklyn, N. Y., will enter the consumer field after the war, Alex M. Lewyt, president, announced recently.

Lewyt Corporation will make office communication equipment; electronic equipment, and products used by industry in their manufacturing processes.

* * *

GAROD EXPANDS

The Garod Radio Corporation, 70 Washington Street, Brooklyn 1, N. Y., has taken on an additional floor.

* * *

RMA SUBSCRIBES TO 6TH WAR LOAN

An RMA subscription of $50,000 to the 6th War Loan was authorized by the association's board of directors recently.

* * *

ELECTRONICS NOT IN SPOT AUTHORIZATION PLAN

Increased military electronic production, vital to the war effort, has made it impossible to issue spot authorizations, according to the WPB.

The WPB statement was issued "to remove any ambiguity" about the application of the "spot" plan to electronic equipment. It said WPB Limitation Order L-265 was amended to provide that no producer shall manufacture any electronic equipment except "to fill preferred orders or to fulfill, under Controlled Materials Plan, any authorized production schedule or authorized program as defined in CMP Regulation I, except a schedule or program authorized under Priorities Regulation 25 ('Spot' authorization plan)."

* * *

PAYNE BECOMES V-P OF FINCH

George Henry Payne, of the board of directors of the Finch Telecommunications, Inc., of Passaic, N. J., has been elected vice-president of the company and chairman of the advisory board for those newspapers desiring to inaugurate facsimile in connection with their regular publications.

Mr. Payne was formerly FCC Commissioner.

* * *

CROWLEY H-F IRON CORE DATA

A 36-page catalog describing Crolite Magicore h-f iron cores has been released by Henry L. Crowley & Company, Inc., 1 Central Ave., West Orange, N. J.

The catalog covers the uses and functions of powdered iron cores; permeability and "Q" of various materials at different frequencies; effects of the addition of adjusting screws; copper cores; mechanical considerations, stand-

(*Continued on page* 80)

WABC-FM ANTENNA

New two-bay G.E. f-m circular antenna recently installed by CBS atop 700-foot building at 500 Fifth Avenue, New York City.

NEWS BRIEFS

(*Continued from page 79*)

ard pieces and sizes; and special cores especially of large dimensions.

A copy is available to any designer, engineer, purchasing agent or production man writing on his business stationery.

* * *

CLAROSTAT INTERIM LINE CATALOG

To span a gap between the wartime and postwar era, the Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y., have published an "Interim Line" catalog. It lists such items as composition-element and wire-wound controls, switches, constant-impedance attenuators, universal metal-tube plug-in resistors, power rheostats, power resistors, voltage regulators, and glass-insulated flexible resistors.

* * *

WIRE RECORDER LEAFLET

A new model of the General Electric magnetic wire recorder has been described in a 4-page bulletin. The new recorder is now available to radio stations. Features include new recording head, new belt drive, new level-winding wire guides, aluminum case.

The G. E. magnetic wire recorder has been used experimentally by a number of stations including WGN, Chicago; WGY, Schenectady; WFIL, Philadelphia; WFBL, Syracuse; and WHIO, Dayton.

G. E. engineers say that while speech can be recorded and reproduced with excellent fidelity, in its present stage of development the unit is not recommended for recording music for broadcast purposes. A unit especially designed for broadcast use and having audio characteristics comparable to electrical transcriptions is planned, but the development may not come until after the war.

* * *

G.E. VISIT DAY PROGRAM

Effective December 1, Wednesday and Friday have become "open-house" visiting days to the G. E. stations in Schenectady.

To make arrangements for a visit, write or wire W. R. David (f-m/a-m) or J. D. McLean (television), Electronics Department, General Electric Company, Schenectady 5, N. Y., a few days in advance of your visit, stating your time of arrival and your requirements for hotel and return train reservation, if any.

* * *

PETERSON NOW WITH UNITED ELECTRONICS

Arnold Peterson has been named application engineer at the United Electronics Company, Newark, New Jersey.

* * *

ROYAL HEADS NEW NBC TELEVISION DEPT.

John F. Royal has been designated vice presi-

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F-M RECORDING ANTENNA

U-h-f doublet receiving antenna picking up signals from four Chicago f-m stations for observation.

dent in charge of a newly established department of television.

Under the new order, Ray Kelly, manager, program production facilities; John T. Williams, business manager, television department; production directors Edward Sobol, Paul Alley, Ernest S. Colling and their staffs will report to Mr. Royal.

* * *

ZIMMERMAN WITH FTR

Frank O. Zimmerman has been named assistant manager of the Chicago sales branch of Federal Telephone and Radio Corporation. Mr. Zimmerman formerly was with Westinghouse Electric Elevator Company at Chicago and Indianapolis. R. A. Vogeler is manager of the Chicago office.

* * *

W.E. CELEBRATES 75TH YEAR

Western Electric observed its 75th anniversary in November. As part of the anniversary observance, employees in key cities from Coast to Coast previewed a feature length motion picture entitled "Heritage for Victory," dramatizing the growth of the organization.

* * *

R. J. HIGGINS APPOINTED TURNER REP.

Royal J. Higgins, 600 South Michigan Avenue, Chicago, Illinois, has been appointed Chicago area representative by The Turner Company of Cedar Rapids, Iowa.

Mr. Higgins was formerly advertising manager of the Hallicrafters Company.

* * *

RCA F-M COVERAGE CALCULATOR

An f-m coverage calculator to assist in planning an f-m station, has been developed by the RCA engineering department. Copies of the rule are available at one dollar each from Radio Corporation of America, RCA Victor Division, Camden, New Jersey.

* * *

D. H. MILLER OF SPEER CARBON DEAD

Dudley H. Miller, president of the Speer Carbon Company, died recently.

* * *

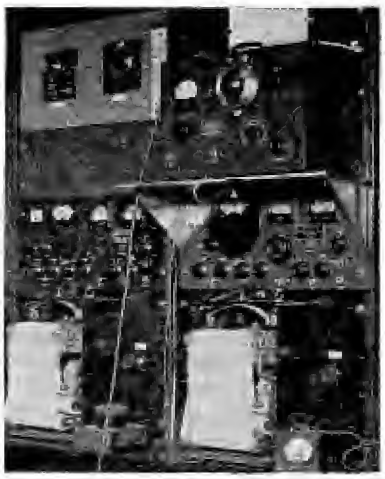
MACHINE SCREW THREAD CARD

A pocket-size card form table of machine screw thread dimensions is being issued free by Manufacturers Screw Products, 222 W. Hubbard Street, Chicago 10, Illinois.

The table shows the nominal diameter and threads per inch (National coarse and National fine) for all standard machine screws and the maximum and minimum major, minor and pitch diameters for each size. In addition, tap drill sizes and diameters for each screw are

(*Continued on page* 82)

F-M RECORDER STATION



Recording response of f-m on special ink recorders. Charts are sent to Washington for evaluation.

NEWS BRIEFS

(*Continued from page* 81)

also given, as well as a handy printed rule. Requests for the cards are to be directed to the engineering department.

* * *

"E" AWARDS

The Hoffman Radio Corp., Los Angeles, has received the Army-Navy "E" production award.

Two white stars have been added to the "E" flags of Clarostat Manufacturing Company, Inc., and the Amperex Electronic Corporation.

The Solar Manufacturing Corporation's number two plant in West New York, New Jersey, the Sharon works of Westinghouse and the Galvin Manufacturing Corporation have won the fourth white star for their "E" flags.

* * *

CANNON WINS APPROVED RATING

Cannon Electric Development Company has received an "Approved" Inspection rating from Major E. P. Higbee, Army Air Forces, Air Technical Service Command, for a period of six months.

* * *

AIRCRAFT TOOLS CATALOG

A 178-page reference manual, containing photographs, blueprint drawings, and full construction details of small hand tools for aircraft production and maintenance has been released by Aircraft Tools, Inc., 750 E. Gage Avenue, Los Angeles 1, California.

There are sections on riveting tools, dimpling tools, angle drills, cutting tools, and bucking bars. One section is devoted to miscellaneous tools, such as strap duplicators, rivet squeezers, pliers, cable spicers, torque wrenches, chip chasers, and other precision-made products. Useful engineering data may be found in a 9-page appendix.

* * *

HERCULES ELECTRIC MOVES TO NEW PLANT

The Hercules Electric and Manufacturing Corporation, manufacturers of d-c/a-c welders, transformers, coils, magnetic clamps, solenoids, rivet heaters, spot welders, fluorescent ballasts and special controls, are now located at 2500 Atlantic Avenue, Brooklyn 7, New York.

* * *

CAIRO COMPANY TO DISTRIBUTE RECEIVERS

The Intercontinental Commercial and Industrial Company, 83 Azhar St., Cairo, have opened a distributing unit, and plan to sell American receivers and sound equipment.

Wide coverage is planned. Mansour & El Hamawy Sons operate the company.

* * *

LEWYT OPENS CHICAGO OFFICE

Lewyt Corporation, Brooklyn, N. Y., has opened

●

ACTION TESTS

Type-test laboratory in Western Electric's Hawthorne works in Chicago to check performance of ship-borne equipment under the same conditions that will be encountered at sea. Bolted to the heavy steel table top, the equipment is rocked back and forth for hours, or days.

a Chicago sales office at 32 North State Street.

B. H. Havens, a member of the New York sales staff, has been appointed manager of the Chicago office.

* * *

WGN EXTENDS DEADLINE IN STUDIO DESIGN CONTEST

Because of the interest in WGN's $10,000 cash prize competition for the design of a studio theater seating 2,000 persons in its proposed Chicago Theater of the Air building to be erected after the war, the deadline for entries was extended fifteen days to December 1.

* * *

WORNER ELECTRONIC EXPANDS

Worner Electronic Devices are now located at larger quarters at 609 West Lake Street, Chicago 6, Illinois.

* * *

GOLDER HEADS GENERAL INSTRUMENT SPEAKER UNIT

Leon Golder, former secretary and sales manager of Rola, has become manager of the new speaker division at General Instrument Corporation, Elizabeth, N. J.

The speaker business will be conducted by the General Electronic Apparatus Corporation, a subsidiary of General Instrument Corporation.

* * *

WESTINGHOUSE APPOINTS FAURIE, ECKSTEIN, AND HERRON

Georges Faurie, formerly with the Delco appliance division of General Motors, has been named advertising and sales promotion manager for the newly created radio receiver division of Westinghouse.

Paul H. Eckstein has been appointed assistant sales manager of the receiver division.

A. L. Herron will manage the receiver cabinet division at Westinghouse. Mr. Herron was cabinet engineer for Stewart-Warner Corporation from 1935 to 1940.

* * *

D. MARTIN JOINS WILCOX-GAY

D. Martin has been appointed chief engineer of the Wilcox-Gay Corporation.

Prior associations include Westinghouse Aircraft Division, de Forest Radio Company, Federal Telephone and Radio Manufacturing Company, Radio Receptor Company and the J. H. Bunnell Company.

* * *

BENDIX PRODUCES OVER 75,000 RADIO COMPASSES

A total of 75,430 radio compasses are said to

(*Continued on page* 84)

●

H-F HEAT SEALING

(*Courtesy North American Philips Co., Inc.*)

Sealing anode and grid caps to bulb of an 833A with a h-f coil. Metal is heated by means of induction. Bell jar is filled with nitrogen to reduce oxidation.

NEWS BRIEFS

(*Continued from page* 83)

have been delivered to allied forces since Pearl Harbor by the Bendix radio division of Bendix Aviation Corporation.

* * *

B-C MILLING CUTTER DATA

A milling cutting data book has been published by the Barber-Colman Company, Machine and Small Tool Divisions, 19 Loomis Street, Rockford, Ill.

This book is based on performance data taken directly from the field. It will be issued without charge upon receipt of a request on company letterhead, and signed by one in a key post.

* * *

RAYTHEON TUBE DATA BOOK

A tube data and substitution chart booklet with complete information on electrical characteristics, and outline drawings and diagrams of all receiving, hearing aid, and special purpose tubes, as well as radio panel lamps has been published by radio receiving tube division, Raytheon Manufacturing Company, Chapel Street, Newton 58, Mass.

A large portion of this book is also devoted to a chart of simplified interchange information, including over 1600 substitutions.

* * *

CARLIN, SWEZEY, JOIN MBS

Phillips Carlin has been named vice president in charge of programs of the Mutual Broadcasting System. Robert D. Swezey has been appointed vice president and assistant general manager at Mutual.

Mr. Carlin and Mr. Swezey were formerly with the Blue network.

* * *

SOWARD GOES TO SUPREME INSTRUMENTS

Raymond Soward has become chief engineer of Supreme Instruments Corporation, Greenwood, Mississippi.

From 1936 to 1938, Mr. Soward was employed as design engineer for Supreme. He was recently a radio engineer in the Signal Corps in Atlanta, Georgia.

Mr. Robert H. Streeter has become a design engineer at Supreme, and will assist Mr. Soward.

* * *

Raymond Soward

Robert H. Streeter

BLACK INDUSTRIES DRILL-TOOL MANUAL

A 24-page hardsteel operator's manual has been issued by the Black Drill Company, division of Black Industries, Cleveland, Ohio.

It contains revised tables on drilling speeds recommended for drilling hardened steels, amplified instructions on the correct procedure for wet and dry drilling and information on the

●

SMITH OF GALVIN HONORED

Donald Henry Smith, left, chief engineer of the Galvin Manufacturing Corporation, Chicago, before WGN microphone acknowledging Chicago Tribune War Workers Award, for his walkie-talkie contribution.

application of hardsteel in tool bits, and tool tips used in machining the hard, tough steels and abrasive copper and aluminum alloys.

* * *

MALLORY WELDING BROCHURE

A 32-page catalog on "Resistance Welding Electrodes and Alloys," has been published by P. R. Mallory & Co., Inc., Indianapolis, Indiana.

The catalog lists the company's complete line of standard spot welding electrodes and water-cooled holders.

A complete listing of "Do's and Don'ts" for improved resistance welding is featured. Stock sizes of Mallory alloys, their various applications and typical physical properties are also included.

* * *

SIGNAL CORPS STANDARDIZATION BOOKLET

A 12-page booklet on Signal Corps standardization, describing the program for the standardization of component parts and materials used in Signal Corps equipment, has been released by the Army Service Forces, Signal Corps Standards Agency, 12 Broad Street, Red Bank, N. J.

Hereafter, the Signal Corps will require the use of only approved component parts and materials wherever possible in the equipment supplied to it. Signal Corps tentative specifications 71-4902 is the medium by which this will be effected.

The booklet has been sent to all prime contractors of Signal Corps equipment and will be sent to all component parts manufacturers and materials suppliers.

An insert in the booklet lists the standard specifications completed under this program as well as those still being processed.

* * *

PEEK JOINS ELECTRONIC LABORATORIES AS S-M

Walter E. Peek has been appointed sales manager of Electronic Laboratories, Inc., Indianapolis. Mr. Peek has been a member of the engineering staff for the past four years, serving in both a design and sales engineering capacity, with particular attention to the vibrator field.

Mr. Peek was chief radio engineer of Noblitt-Sparks Industries, Columbus, Indiana, for several years.

* * *

UNITED ELECTRONICS' RETIREMENT PLAN

A pension trust plan for employees of the United Electronics Company, Newark, was announced recently.

The pension plan provides for participation by the employees but the employees do not contribute to the fund. All contributions are made by the company.

Coverage includes all employees who have been at the plant for 18 months or more and are over 21 years of age and under 55½ years. Eligibility will be determined each year on November 1 and any employee not eligible this year may apply next year.

The rate of pension is approximately 21½ per cent of the participating employee's base pay. A minimum of $20 monthly has been established. An employee receiving an annual salary of $2,000 would receive $35 monthly.

Payments will begin at the retirement age of 65 and will continue for the life of that employee. In the event of death before 10 years' payments have been made, the beneficiaries will receive the remainder of the payments up to ten years. In the event of death before retirement, the beneficiaries, however, may settle for a cash settlement in a lump sum equal to 100 times the monthly payment.

* * *

G. E. PROMOTES SHATTUCK, NELSON, BURNS AND LEEDS

Donald Shattuck has been appointed manager of the contract receiver section, specialty division of the electronics department, General Electric.

In this capacity, Mr. Shattuck will have charge of a newly organized section of the division with headquarters at the Thompson Road Plant, Syracuse.

J. E. Nelson is now sales manager of industrial tubes. He will be responsible for the sale of all the industrial tubes made by the division. His headquarters will be at Schenectady.

Gordon E. Burns has been named supervisor

(*Continued on page* 86)

NEWS BRIEFS

(*Continued from page* 85)

of personnel in the electronics department at Schenectady, N. Y. Mr. Burns formerly was in charge of personnel work for the department's tube division.

L. M. Leeds has been appointed manager of the electronics laboratory. W. C. White, formerly in charge of this laboratory, has been appointed the electronics engineer of the G.E. research laboratory.

Mr. Leeds is stationed in Schenectady and will have charge of electronic research and advanced development for the electronics department.

* * *

SHAKEPROOF FOLDERS

Four folders covering application data on thread-cutting, screws and lock washers, have been released by Shakeproof, Inc., 2501 N. Keeler Avenue, Chicago, 39, Illinois.

* * *

AEROVOX ENGINEERING BULLETINS

Latest releases of the "Aerovox Research Worker" contain data on capacity quality factors and a dictionary of capacitor applications and recommended types.

* * *

WESTINGHOUSE INSTALLS R.R. RADIO AT PLANT

Six f-m transmitters, linking a central railroad dispatcher's office and five diesel-electric locomotives in two-way communication, is expected to be in operation on terminal railroad lines of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., within three months.

The main station will use a 50-watt unit. The mobile transmitters will be of 40-watt power. All six stations will broadcast in the 10-meter band.

Authorization for construction of the unique radio system has been granted by the FCC, and WPB priorities for the necessary equipment accompany the authorization.

A class 1 engineer will be on duty in the central station, and class 3 operators will be on duty elsewhere.

* * *

DOC POWER CELEBRATES 23D YEAR IN RADIO

Dr. Ralph L. Power, Los Angeles radio counsellor, celebrated his 23d year in radio in October. He began in 1922 when he left a professorship at USC to become a radio announcer and newspaper radio editor locally.

* * *

BENDIX NAMES ROCHESTER AND VILAS AS DISTRICT MANAGERS

Samuel Rochester, formerly buyer for Bendix Radio, has been appointed district manager of the home radio unit in the Middle Atlantic territory, with headquarters in Baltimore.

Royal Vilas, former WPB official, has become home radio district manager with headquarters in Atlanta.

Samuel Rochester

Royal Vilas

* * *

MINNESOTA MINING, GRINDING AND FINISHING BOOKLETS

Four publications illustrating and describing the 3-M method of grinding and finishing have been released by Minnesota Mining and Manufacturing Company, Saint Paul, Minnesota.

One booklet in the new series entitled "Step Up Production with the 3-M Method of Grinding and Finishing," is for purchasing agents, work managers, production managers, chief engineers and plant superintendents.

Included are photographs of production jobs, a formula for determining abrasive belt sizes and placement of backstand idlers, complete data on 3-M abrasive belt sizes and grits and segment face contact wheels.

The other booklets describe grinding and

finishing of small parts and tools, heavy duty grinding and finishing of flat or curved surfaces.

* * *

M. H. COOK PROMOTED BY BELL LABS

Morris H. Cook has been appointed director of specialty products development of Bell Telephone Laboratories. He comes from the Hawthorne works of Western Electric where he was superintendent of manufacturing engineering.

* * *

PIANO MAKERS USE OPERADIO PAGING SYSTEM

Steinway and Sons, piano manufacturers, have installed an Operadio industrial music and voice-paging system in their N. Y. plant.

* * *

GERMAIN RETURNS AS STROMBERG-CARLSON S-M

E. S. Germain, prewar radio sales manager of Stromberg - Carlson Company's Pacific Coast division, has resumed that position.

Mr. Germain, in early 1942, was drafted from his sales post in the San Francisco office to become manager of the company's Government sub-contract sales division in Rochester.

* * *

TELECHRON BOOKLET

A 20-page booklet discussing synchronous motors, instrument movements, gear trains and industrial clock equipment has been prepared by the Warren Telechron Company, Ashland, Massachusetts.

* * *

PHILCO APPOINTS GILLIGAN AD MANAGER

John F. Gilligan has been appointed advertising manager of Philco Corporation. Mr. Gilligan joined Philco in 1922.

* * *

GUBB TO SERVE ON CORNELL BOARD OF TRUSTEES

Larry E. Gubb, chairman of the board of directors of Philco Corporation, has been elected to the board of trustees of Cornell University, at Ithaca, N. Y. Mr. Gubb was graduated in 1916 from Cornell, and is president of the Cornell Alumni Association.

* * *

MOTOROLA DEALER BULLETIN

A 24-page, four-color book, entitled "When Motorola Radio Comes Home from War," has been issued by the Galvin Manufacturing Corporation, Chicago.

Several action photos of the handie talkie are included as well as views of the walkie talkie, guidon set and other Motorola radio war equipment.

* * *

PRICE BROTHERS COMPANY EXPANDS POSTWAR PROGRAM

Six manufacturer's agents have been added to the sales unit of Price Brothers Company, Frederick, Md., as part of a new postwar selling program. J. J. Schmidt was recently appointed general sales manager.

Manufacturers' agents appointed include Gerald G. Ryan Co., Chicago, Ill.; Bert A. Hansen, Buffalo, N. Y.; E. J. Wall, Lakewood, Ohio; L. R. Ward Company, Dallas, Texas; Fry & Roberts, Hollywood, California; and Gail Halliday, Denver, Col.

* * *

FLUXMETER DATA

An 8-page catalog describing a multirange fluxmeter, model F, has been published by Sensitive Research Instrument Company, 9-11 Elm Avenue, Mount Vernon, N. Y. Data presented includes methods of use and search coil design.

* * *

CONCORD RADIO EXPANDS

Concord Radio Corp., 901 W. Jackson Blvd., Chicago, has taken additional space for the kit and cable department, and warehousing facilities.

TELEVISION

(*Continued from page 38*)

and a 240′ copelene coaxial leadin were used. Two setups were employed. In one, the dipole was placed on the porch bannister facing S 18° W and about 18′ above ground level. In the second instance, the rhombic was erected on a bearing of S 18° W at a horizontal level. At the far end the antenna was approximately 35′ above ground, while at the receiving end, 14′ above ground.

All readings were made in a room facing southwest directly below the dipole antenna.

Discussing the method of recording, the report states that the receiver was calibrated in two ways. First, μv versus ma at 50 mc, and r-f gains of 1.0, .1, .01, .001; and second, frequency versus set sensitivity with respect to sensitivity at 50 mc as unity. These calibrations provided two sets of curves.

In deriving the input signal strengths, the Du Mont engineers determined which one of the four r-f gain settings would be used to give about mid-range deflection for each station. To obtain the maximum ma reading for this setting, the curve shown in Figure 1, was used. Then, according to the report . . . "the signal for this ma reading at 50 mc was noted. This μv signal multiplied by the sensitivity factor obtained from the curve in Figure 2, gave the actual signal-strength voltage at the receiver terminals from the observed station at the observed frequency. In addition to tabulated readings, a permanent record was made by the use of an Enterline Angus graphic recorder, which over a period of time showed the variation of signal strength from the stations received.

Further recordings of signals received were made by film and movie camera."

•

IRE WINTER MEETING

THE 1945 winter technical meeting of the Institute of Radio Engineers will take place during a four-day interval beginning January 24, 1945 at the Hotel Commodore in New York City.

Technical sessions will begin on Thursday, January 25, at 2:00 P.M., in the grand ballroom. Speakers will include Jerry P. Minter, K. A. Norton, Harold A. Wheeler, Murray G. Crosby, Coleman Dodd, John D. Reid, R. L. Kelly, N. H. Green, E. D. McArthur, D. R. Hamilton, J. R. Pierce, Clayton E. Murdock, Major H. A. Zahl, Karl Van Dyke, Major Edward W. Johnson, I. E. Fair, C. W. Harrison, Clifford Frondel, Charles Roddy, Virgil E. Bottom, W. D. Cockrell, G. W. Klingaman, Paul D. Zottu, Wallace C. Rudd, Eugene Mittelman, George H. Brown, Captain E. M. Webster, Alfred N. Goldsmith, Allen Easton, R. F. Wild, R. L. Freeman, W, A. Hayes and Ralph Brown.

Subjects to be covered will include quartz crystals, vacuum tubes, industrial electronics, radio links and relays, v-h-f and u-h-f signal ranges, carrier amplitude and p-m reception, klystron characteristics, disk-seal tubes, reflex oscillators, broad-band aircraft antenna systems, solid dielectric lines, etc.

TRANSMITTERS

(*Continued from page 64*)

Poulsen's design before even limited success was attained, but the problem of modulation was recognized as not soluble with the microphones at hand, or procurable.

It was with what had been learned during the latter years of World War I, about radio telephony, that radiophone broadcasting was given a start in 1920. The needs of war seemed to invite attempts at long distance operation, and for this purpose a large amount of equipment, and a bottomless source of replacement tubes were demanded—an undertaking possible only to the Navy Department, and to the telephone company. Radio amateurs and experimenters in this country had for years been making telling strides in developing radiotelegraph devices and services. Radiotelephony for a little time did not particularly intrigue the interest of the amateurs. For given equipment at cost its range was small compared to radiotelegraph. And tubes were priced at six dollars each!

The American experimenter, however, is a rugged and a determined soul. It was not long after the large companies had demonstrated the practicability of radiotelephony, that others entered the scene to simplify, modernize and project improvements.

At de Forest's laboratory were R. F. Gowen and C. V. Logwood; at City College, A. N. Goldsmith, Carl Dreher and Julius Weinberger. Here and there were others who undertook to utilize radiotelegraph parts as far as possible in making up radiophone outfits, satisfied at first with limited ranges. It was a time when no one regarded any *hook-up* as likely to suit him for longer than a few days, or a few hours.

Persons having receivers with detectors and two-step amplifiers (as they were then called) could pick up transmission from these sets at 15 to 20 miles, provided interference was not unreasonable. One of these transmitters at City College, New York, operating on 300 meters, was picked up at Princeton, N. J., 50 miles away, and at Poughkeepsie, N. Y., 75 miles away. For the experimenter the problem of available power was difficult in comparison with the power required for radiotelegraph operation. Some sets were operated on 110 or on 220 volts, which worked well enough but over shorter distances. The lucky fellows were those who could afford motor-generators having 350 to 500 volt output for the plate circuit. With the 235-volt input the antenna current danced around 0.8 to 1.2 amperes.

COAXIAL CABLES

(*Continued from page* 54)

plastic. By introducing styrene units into the chain, the bulky phenyl groups prevent the close packing of the chains and decrease the molecular attraction. Thus, instead of getting a hard rigid material like polystyrene, a typical rubbery product is the result.

Getting back to the problem of preparing a suitable dielectric for high-frequency transmission lines, it is apparently necessary to have a material that is intermediate between a plastic and a rubber, and yet which has satisfactory electrical properties.

The optimum electrical properties are found in the substantially non-polar materials such as hydrocarbons; for example, polybutene, polystyrene and polyethylene.

In the early days of the development, in this country, of high-frequency transmission lines having semi-flexible solid insulations, no satisfactory material was available. The familiar *marshmallow* type of insulation made by stiffening polybutene with various resins was not at all satisfactory for the severe service requirements. Because of the lack of a suitable dielectric, we undertook the development of such a material in January, 1942. Our method of attack on this problem was to take advantage of the dielectric properties of polystyrene and combine these with the rubbery properties of polybutene. This investigation involved the preparation of 332 different compositions before a satisfactory material was developed. The final composition was rubbery, had a power factor of 0.0006 and a dielectric constant of 2.42 at frequencies in the range of 10-400 megacycles.

Transmission lines manufactured with this dielectric, were suitable for use over a temperature range of –40°C to +85°C. It must be admitted, however, that the processing difficulties encountered in the use of this material were large and the utmost skill and care was necessary, particularly during the extrusion operation, to hold the size tolerances to the degree required for impedance uniformity.

In the spring of 1943, polyethylene became available for use in this country, and because of its properties, has now been selected as the preferred dielectric for all high-frequency transmission lines.

With polyethylene, a temperature range of –40°C to +100°C can be attained, while the power factor and dielectric constant of the material over

a very wide range of frequencies is 0.0003 and 2.3 respectively.

Further search and development will undoubtedly produce new materials having even more desirable properties, but the further improvements to be expected now are minor in character.

The outer protective jacket of a high-frequency transmission line is most usually a thermoplastic type of material. It must possess:

(*a*)—Toughness.
(*b*)—Resistance to abrasion.
(*c*)—Low temperature flexibility.
(d)—High temperature stability.
(*e*)—Resistance to sunlight and ozone
(*f*)—Resistance to gasoline and oil.
(*g*)—Resistance to water.
(*h*)—Flame resistance.

It is well known that the pure hydrocarbons are readily combustible and that they are attacked by gasoline and oil, and therefore, they cannot, in general, be used as jacketing materials.

The best flame resistant materials are those which contain in their molecules halogen atoms such as chlorine, bromine or fluorine. Resistance to gasoline and oils is also encountered in such molecules. It is apparent that the arrangement of the atoms and the molecules in the material determines its physical behavior, and in order to get flexibility the chains must not be allowed to pack too tightly together or have too strong a molar cohesion. In a material like polyvinyl chloride the large bulky chlorine atoms tend to prevent close packing of the chains, while the forces between the chlorine atoms on one chain and the hydrogen atoms on the other chain are reasonably strong. The material is, therefore, a rather tough plastic, and in order to make it rubbery it is necessary to still further weaken the intermolecular forces and keep the chains further apart. This is done by the addition of suitable plasticizers. By copolymerizing vinyl chloride with a small amount of vinyl acetate, the chains are kept further apart than in the case of pure polyvinyl chloride by virtue of the bulky acetyl groups and in this way less plasticizer is required to bring this copolymer to an equivalent state of rubberiness. The development of suitable plasticizers for this purpose which will impart the optimum properties to the plastic has been another contribution of the chemist. And some of the more recent developments in this field with particular reference to the changes in properties of a high-frequency transmission line with heat ageing have been of paramount assistance to designers and users of precision testing equipment.

This paper has covered very generally the subject of the influence of molecular configuration on the electrical and physical properties of plastic materials particularly applicable to a rather specialized field, namely, high-frequency transmission lines. However, the same general considerations hold for all types of insulating materials and plastics, and the next few years are bound to be ones in which the basic theoretical concepts discussed here will receive a very thorough trial and a more adequate investigation.

THE INDUSTRY OFFERS . . .

G. E. 2,000,000 X-RAY

A 2,000,000-volt mobile x-ray unit has been developed in the research laboratory of G. E. at Schenectady. G. E. engineers state that the unit can x-ray foot-thick steel.

In radiographing an eight-inch steel casting the two million-volt outfit is said to be 78 times as fast as the million-volt.

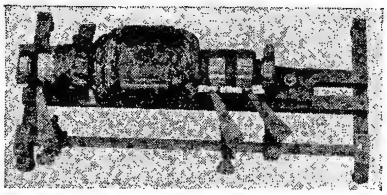
William F. Westendrop and Dr. Ernest E. Charlton collaborated in the development of the machine.

* * *

CARTER MULTI-GAUGE COMMUTATOR CHECK

To test the eccentricity of three or more commutators simultaneously to within .0001", a multi-gauge check has been developed by Carter Motor Company, 1608 Milwaukee Avenue, Chicago.

With this tolerance gauge, the armature is set into the jig and rotated. Indicating gauges applied to the commutators, read the deviation from true in thousands of an inch. The sections which do not meet specifications can then be trued-up. Since the armature is tested complete with bearings, a comprehensive check of the entire assembly is said to be possible.



* * *

G. E. HIGH-VOLTAGE D-C SUPPLY

High-voltage d-c power supply units, available in ratings up to 50,000 volts d-c, have been announced by G. E.

Each unit consists of a full-wave kenotron rectifier, a filter that is said to limit voltage ripple to 1% or less, and complete control equipment. The d-c output voltage can be controlled, from zero to maximum, with a motor-operated, dry-type, variable autotransformer.

Dust filters are also included. Portable units are also available; cabinet furnished on a four-wheel dolly truck.

A safety feature incorporated in the unit consists of an automatic solenoid-operated discharge switch.

* * *

SPRAGUE HUMIDITY PROTECTION KOOLOHMS

Humidity protection is now included on all standard Sprague koolohm wire wound resistors.

This construction includes a glazed ceramic outer shell and a new type of end seal.

Type numbers of the resistors remain the same except for the fact that the letter "T" has been added to the old designation.

* * *

GREEN ELECTRIC MAGNETIC TESTING MOBILE RECTIFIER

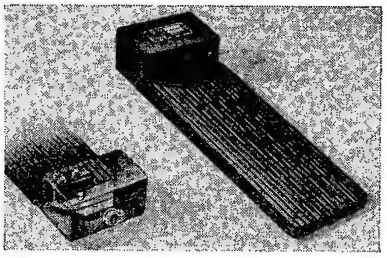
A d-c rectifier with a fan-cooled selenium unit for magnetic particle inspection process that is said to reveal flaws in propeller shafts has been developed by W. Green Electric Company, 130 Cedar Street, New York 6, N. Y.

The unit is said to have a continuous capacity of 1500 amperes d-c, with proportionately higher rating for intermittent operation. The output voltage is adjustable in eight steps from one to six volts. Rectifier uses a three-phase, 440-volt, 25-cycle power supply.

* * *

G. C. FOOT SWITCH

A flat foot test switch MF, for actuating one to eight circuits has been produced by General Control Company, 1200 Soldiers Field Road, Boston 34, Mass. The foot rest is ½" above the floor, and requires 1/16th" throw. This is said to allow the operator to support his whole foot nearly at floor level.



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C. E. P. HERMETIC TERMINALS

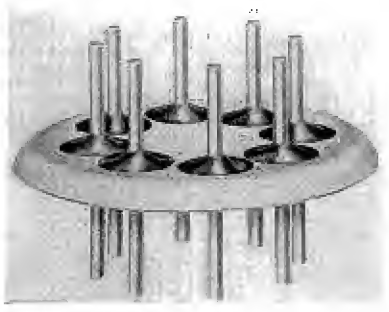
Hermetic terminals, fusite type, which are said to withstand a five-cycle thermal shock test and do not crack or fail at temperatures ranging from —50° C to +90° C have been announced by Cincinnati Electric Products Company, Carthage at Hannaford Avenue, Cincinnati 12, Ohio.

The terminals are also said to maintain insulation properties at approximately 2,500 volts.

Two standard types of terminals, one approxi-

mately 1¼" in diameter, which has a capacity of from two to nine terminals, the other slightly under an inch in diameter, carrying from two to seven terminals, are made.

Another feature of the terminals is said to be the complete interfusion of the glass and cold-rolled steel.



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ACME POWER TRANSFORMERS

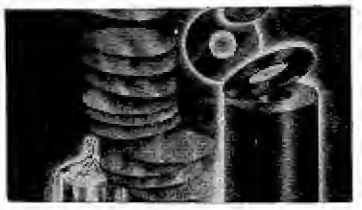
Pressed steel end covers are used in an air-cooled transformer design announced by Acme Electric and Mfg. Co., Cuba, N. Y. Temperature rise is said to remain at 55° C. continuous. The pressed steel design covers all Acme air cooled transformers, auto and insulated types from 1 kva to 15 kva with primaries up to 2400 volts.

* * *

STACKPOLE CARBON PILE RHEOSTATS

Continuously adjustable carbon rheostats formed on carbon disc piles, are now being made by Stackpole Carbon Company, St. Marys, Pa. By changing the pressure applied to these piles, different resistance values within their range is made available without opening the electrical circuits in which they are connected. The pressure to vary the resistance may be applied electrically, mechanically, centrifugally or hydraulically. Uses range from both generator and line voltage regulator applications to speed control through governed field current on motors.

Carbon piles are said to be supplied in practically any length pile and diameter required. Typically, a carbon disc pile 1½" long composed of discs .432" in diameter is said to permit a resistance range of from 60 ohms with 1 ounce pressure to .7 ohm at 32 pounds pressure.



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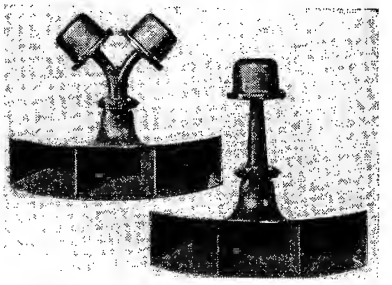
LANGEVIN SPEAKERS

A cast-aluminum loudspeaker, 26-8, designed to operate through high noise levels and with uniform distribution over horizontal angles of 120 and vertical of 40, has been announced by the Langevin Company, 37 W. 65th St., New York 23, N. Y. It can be used for voice reproduction by itself or as a high-frequency component to a wide-range system.

Said to handle power input of 40 watts when equipped with 2 Jenson U-20 drive units: 22" wide, 14½" deep, 20" high.



* * *

AMCO PLASTIC CONDENSERS

A new assortment of plastic condensers have been announced by American Condenser Company, 4410 Ravenswood Ave., Chicago.

* * *

DU MONT FERROGRAPH

Comparisons of ferrous materials as to analysis and heat-treatment are provided by the Ferrograph, a metal-testing instrument announced by Allen B. Du Mont Laboratories, Inc., Passaic, N. J. This instrument said to be available on outright sale, can be used to obtain information about iron and steel.

The Ferrograph utilizes the transformer principle of operation. A 23-cycle exciting current is fed into the primary coil while the output of the secondary is controlled by the magnetic characteristics of a metal sample introduced into the coil. The voltage from the secondary is filtered and the fundamental 23-cycle wave is impressed on the horizontal axis of the cathode-ray tube. The third harmonic is viewed on the vertical axis of the instrument.

The first and third harmonics will vary in phase and amplitude with variations in the

(*Continued on page* 94)

THE INDUSTRY OFFERS . . . —

(*Continued from page* 93)

analysis and heat-treatment of steel or iron. Sorting of commonly used SAE steels is quite practical although in some cases the difference obtained is very small and may not be sufficient for sorting production lots of parts. It is said that about 80% of the mixtures of two types of iron or steel that can occur, can be sorted by the Ferrograph.

Du Mont engineers say that the low-frequency exciting current has an advantage over the use of 60-cycle in that the reversals of magnetizing flux are slow enough to give some appreciable effect from residual magnetism. A long-persistence screen is used in the cathode-ray tube to avoid flicker from the low frequency used. A relay turns the cathode-ray beam off automatically unless there is a sample in the test coil. The flux in the test coil can be varied widely. It is possible to correlate with different variables by using different flux densities in the Ferrograph coil.

Calibrated scale provides ten divisions per inch, with the 10th division accentuated. Instrument operates on 115 volts, 40-60 cycles. Dimensions: 12½" w, 17¼" h, 23¾" d; weight, 100 pounds.

* * *

AMP SOLDERLESS REPAIR KIT

An electrical wiring kit for general solderless wiring is now being manufactured by Aircraft-Marine Products, Inc., 1591F North Fourth Street, Harrisburg, Pa.

The kit comprises a 6-purpose installation tool which cuts and strips the wire, indicates stud sizes, and crimps terminals to the wire. Also included in the kit is an assortment of 100 AMP solderless terminals of the most commonly used types.

* * *

G. E. PHOTOMETER

A transmission photometer for measuring the amount of light transmitted through very small areas of spectrographic plates, has been announced by G. E.

Requires a constant power supply of 6 volts, a-c or d-c, with an approximate capacity of 30 amperes. Consists essentially of a light source, an optical system, a galvanometer, a light-sensitive cell, and a mechanical stage for accommodating the plate. This stage, which has a three-point, ball-bearing suspension, is moveable in three directions.

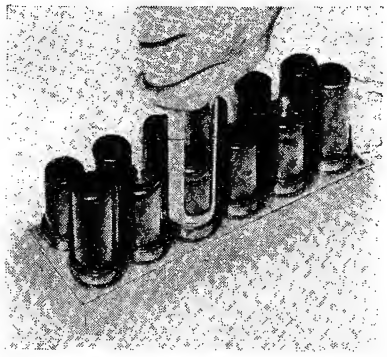
When measuring the light transmitted through a plate, the latter is mounted on the mechanical stage and light from a 6-volt, 18-ampere projection lamp in the optical system

is collected by a condenser lens and focused on a wide-aperture lens, thus producing an image of the condenser lens on the plate. Magnified by an objective lens, this image is then cast upon a rectangular-shaped diaphragm located in front of the light-sensitive cell. The current output of the cell, which is the degree of light transmitted through the field of the plate, is shown on the galvanometer scale.

* * *

BMP TUBE EXTRACTOR

For extraction of standard size metal tubes, the BMP Company, Boonton, N. J., have designed a metal tube extractor. Constructed of one-piece steel, plain, zinc or cadmium plated.



* * *

TUBULAR PLYWOOD MASTS

A portable, telescopic, tubular plywood antenna mast has been announced by the Plymold Corporation, Lawrence, Mass. Heights up to 90' are available on order, with standard heights of 50', 55', and 75' carried in stock for immediate shipment. All masts are designed in sections not exceeding 12' in length. In shipment, these sections nest into one another forming one or two packages of small dimensions. Fittings, stays, and erection equipment are packed in a reusable case.

Masts are furnished with accessories so that they will be suitable for use either as an end support for horizontal antennas, or as a complete support for u-h-f antennas. For horizontal antennas, masts have been designed and tested for a maximum antenna pull of 10,000 pounds.

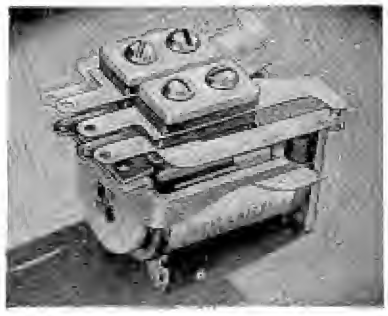
Left, mast and accessories packed for shipment. The 55' mast illustrated has a shipping weight of approximately 200 pounds. Below, method of erection. Mast is assembled horizontally on the ground and then raised by means of a boom and tackle.

* * *

BETTS & BETTS COROSEALED RELAYS

A midget type relay, hermetically sealed (corosealed) in a metal shell has been produced by Betts and Betts Corp., 551 W. 52d St., N. Y., 19, N. Y.

Units are normally sealed with content of pre-filtered dry air but can be furnished with inert gas or pressurized content when desired. Incorporates a standard octal plug base to facilitate testing. Unit is 1-11/16" long, 2⅛" including prongs; weight 4 ounces.



* * *

STACK PLASTIC CLAMPS

Harness clamps of fabric-based phenolic are now being manufactured by Stack Plastics, 5835 West Washington Blvd., Culver City, California.

Clamps can be bolted or riveted directly to any bulkhead, wall or chassis.

* * *

U. M. PORTABLE MICROPHONES

Type CU-1 and CU-2 microphones for mobile and marine and aircraft installations will be reissued early in 1945 by Universal Microphone Co., Inglewood, Cal.

Button impedance is 200 ohms and output approximately 30 volts rms across the microphone transformer secondary. Double-pole single-throw, press-to-talk switch connects microphone and relay circuits.

Motor noises, on mobile installations, are said

(*Continued on page 96*)

THE INDUSTRY OFFERS . . . —

(*Continued from page* 95)

to be damped out by anti-noise design. Both models are single buttons with plastic cases.

The CU-1 has a three-way plug, while the CU-2 has the PL-68 telephone type of plug.

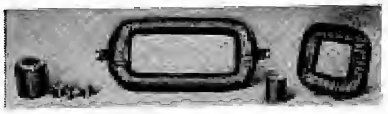
Universal will also resume production soon with its KD and 15 mm's, both dynamic; 200 series, handi-type; 800 velocity series; and the X-1 and XX, both carbons, as postwar microphone releases.

* * *

VACUUM IMPREGNATION

Methods of impregnation of coils, armatures, transformers, etc., under pressure have been developed by Vacuum Impregnating Works, 638 Federal St., Chicago, Ill.

The methods are said to provide higher sustained voltages without overload, elimination of wear due to creeping of coils, prevention of insulation charring, etc.



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SLIDE-RULE DECIMAL POINT LOCATOR

A decimal point locator and slide rule that is said to determine the decimal point mechanically in involved expressions with results up to 19 places, has been announced by Pickett & Eckel, 53 W. Jackson Blvd., Chicago 4, Illinois.

Scale arrangements are said to afford 30-inch scale accuracy, for cube root; 20-inch scale accuracy for square root; synchronized scales to permit result, square root, cube root, and log readings to be taken off the same one setting of the hairline.

An illustrated instruction manual has been written by M. L. Hartung, associate professor of the teaching of mathematics, The University of Chicago.

The decimal point locater and slide rule is 11" long, 2" wide, ⅛" thick.

* * *

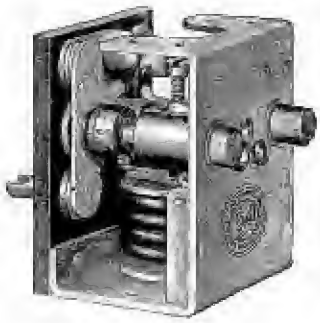
G-M OVERLOAD CIRCUIT BREAKERS

Circuit breakers designed for the protection of either a-c or d-c circuits, that may be equipped with as many as three separate coil windings, providing a single unit for operation on different voltages has been announced by G-M Laboratories, 4300 N. Knox Avenue, Chicago, 41, Ill. They are said to have no appreciable time lag, and thus can be used with power vibrators or other electronic equipment where it is desired to open the circuit instantly when a predetermined overload occurs.

Respective windings may have a different number of turns and be of different size wire so proportioned that tripping may occur on overloads of three widely separated values from a fraction of an ampere up to 70 amperes. Each winding has an independent terminal connection so that the current value at which the circuit breaker operates is dependent upon the terminal to which the load is connected. For applications having only 1 tripping current value, single coil windings can be supplied.

The energy loss occurring in the series circuit is said to be low. Contacts are of ⅜" diameter silver. Series coils are wound with heavy gage wire in relation to the normal current they carry. The double contacts are brazed to heavy silver plated copper bars. A guide prevents the contact assembly from shifting its position. These circuit breakers are usually factory adjusted to trip at twice the normal current value with a tolerance of plus or minus 25%. They

are not designed for operation on smaller overloads or on closer current tolerances.



* * *

HICKOK MAGNETIC FLUXMETER

A fluxmeter, 256, utilizing an electronic circuit so connected to an indicating meter that when the exploring inductor is placed in a magnetic field the indication of the meter will be in proportion to that field, has been developed by the Hickok Electrical Instrument Co., 10529 Dupont Avenue, Cleveland, Ohio. Model is designed to operate from 105-120 volts a-c, 50-cycle circuit.

Magnetic flux measurements can be compared within plus or minus 3%. Higher accuracy can be obtained by calibrating the instrument with a known gauss standard and using it shortly afterwards.

Has one sensitivity control, a four-position control, that serves the dual-purpose of turning the instrument off and selecting the three sensitivity positions. The balance control is used to pre-set the meter at zero.

Supplied with one standard exploring inductor that can be used to measure air gaps ½" or larger, or bar or disc type magnets.

Meter is a Hickok 4" rectangular size. Width, 9½"; height, 10½"; depth, 5"; net weight, 10 ounces.

•

U-H-F POWER SUPPLY

(*Continued from page* 62)

to conduct away or radiate the heat generated by losses in the klystron. It is therefore necessary to cool the rhumbatrons and for this purpose the manufacturer* recommends an air stream of 50 cfm. This air stream must be directed past the tube in a way to effectively cool the klystron.

Power Supply

To prevent injury to certain parts of the apparatus it was necessary that

(*Continued on page* 99)

(*Continued from page 97*)

the power be applied successively to different tubes or tube elements. The required delays were timed automatically and started by turning on the line switch. If the power line was momentarily disconnected, the klystron returned to normal operation with the minimum required delay by virtue of the thermal actuated delays used.

With the line switch thrown to the *on* position, voltage is applied to the large rectifier heaters, the klystron heater, the large regulator heaters (812's) and to the heaters of the 6SF5's. The time delay switch was set for a preheating period of 40 to 50 seconds. The 6SF5's do not require preheating but by preheating them the entire regulator works when the delay switch closes, thereby applying the accelerating voltage to the klystron at the instant the switch closes. Closing also applies the line voltage to the control grid supply in which the tubes are cold. The control grid voltage is applied later, dependent upon the tubes' warm-up time. The length of the second time delay is not critical providing there is a finite delay time. The second delay prevents the positive voltage being applied to the control grid before the accelerating voltage is applied. The high control grid current which would result might possibly burn out the control grid or cause the tube to become gaseous.

High Voltage Protection

The potential differences of some parts of the power supply are as high as 4,000 volts. Higher potentials would have been encountered in a power supply designed to deliver the full 3,000 volts to the klystron which is the rated maximum accelerating voltage. The insulation requirements for some components in such a supply would require specially designed or over-rated and bulky parts. However we found that a maximum accelerating voltage of about 1,800 volts did not reduce the overall flexibility for performing laboratory experiments, was sufficient for the klystron to deliver a reasonable amount of output power, and reduced the possibility of injury to the operator. For these reasons and because it was felt that standard parts should be used when possible, the lower voltage supply was thought preferable for this application.

To prevent injury by electric shock, due to a high potential, outside the case, all inputs were fused in both sides of the line and all transformer cases and cores grounded to the chassis. Transformer T_{12}, connected across the line with the center tap, line side, was grounded to form a d-c path from both sides of the line to ground. The fusing was broken up in such a way that it also supplied the usual overload protection. To prevent a high voltage appearing on the signal input terminals, terminals *A* and *B'* were connected directly to ground.

For some applications it was found desirable that the terminals *C, C'* be balanced with respect to ground. To protect this circuit and to keep *C, C'* above ground, we made a high voltage trap of F_{10}' and R_{23} and F_{10} and R_{24}. If the input side of the transformer rises to more than 500 volts above ground, the fuses will blow, thus preventing the terminals from becoming hot.

For further protection the leads to the klystron were enclosed in an armored metal cable with the outside metal shield grounded. Packard cable or an equivalent must be used for the individual wires in the cables.

Voltage Regulation

Two voltage regulated d-c supplies are used to provide power for the klystron. The larger supply provides energy for the beam current, and the other supplies the control grid and collector anode voltages. Both supplies must be well regulated and must also be variable over a wide range of voltages.

The accelerating voltage is one of the primary determining factors in whether or not the tube will oscillate, and it also has a very appreciable effect on the frequency of the output. Thus for both operating and frequency stability the voltage must be very well regulated. The variation of frequency with accelerating voltage may be as high as 10-kc per volt for a klystron having a resonant frequency of about 3,000 mc. The greatest need foreseen for constant frequency, and therefore constant voltage, will be encountered when the tube is being frequency modulated. For an f-m bandwidth of 100 kc (100 kc for maximum signal modulation) a stability of 1 kc and an even smaller hum modulation are desirable and are provided by this power supply. The circuit used appears in the RCA tube manual; its operation is analyzed in several texts.** The ripple voltage is about 0.01 volt peak. The power supply may be slightly simplified at the cost of increased maintenance by substituting a *B* battery as the reference voltage between the grid of 6SF5 and the negative side of the accelerating voltage supply.

[*To be continued*]

*Sperry Gyroscope Company.

**Brainerd, Khoeler, Reich, Woodruff, *Ultra High Frequency Techniques.*

TECHNICAL NOTES

Excerpts from New Home Study Lessons Being Prepared under the Direction of the CREI Director of Engineering Texts

Circuit Equivalents

CREI has just published a new article on Circuit Equivalents. This particular section deals with another practical example of two circuits equivalent to one another. The example is that of the low frequency compensation for a video amplifier stage.

These articles on Circuit Equivalents are published in the CREI NEWS for the purpose of acquainting engineers with methods of analyzing and utilizing networks that occur in the communication art. It is hoped that this series of articles dealing with a subject that is not specifically covered in the ordinary text book will be of interest and value to all radio engineers. Further examples of equivalent circuits will appear in forthcoming issues of the CREI NEWS.

This publication is issued monthly by the Capital Radio Engineering Institute, and is free for the asking. Merely write and ask for the January issue of the CREI NEWS and your name will be placed on the mailing list to receive it regularly. In doing so you will incur no obligation whatsoever.

The subject of "Circuit Equivalents" is but one of many that are being constantly revised and added to CREI lessons by A. Preisman, Director of Engineering Texts, under the personal supervision of CREI President, E. H. Rietzke. CREI home study courses are of college calibre for the professional engineer and technician who recognizes CREI training as a proven program for personal advancement in the field of Radio-Electronics. Complete details of the home study courses sent on request . . . *Ask for 36-page booklet.*

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ADVERTISERS IN THIS ISSUE

COMMUNICATIONS—DECEMBER, 1944*

NEW FREQUENCY METER and MONITOR

for HIGH FREQUENCY SERVICES—1500 kc to 200 Mc

For measuring and monitoring the carrier frequency of a-m transmitters, these two new G-R instruments offer many operating advantages over equipment formerly available.

With the Frequency Meter, readings are substantially independent of amplitude of modulation, input waveform and input voltage. Over very wide ranges, changes in any of these do not affect the meter indications. The instrument requires no direct connection to the transmitter . . . a foot or two of wire provides ample coupling. The indicating meter has six ranges with full-scale values of 200 cycles, 600 cycles, 2 kc, 6 kc, 20 kc and 60 kc.

One of the most useful features of the Frequency Monitor is its great sensitivity. It can be used to monitor mobile stations. The numerous operating conveniences include: a panel switch to select any one of four temperature-controlled quartz plates; a "stand-by" control to maintain operating temperature continuously with the tube circuits disconnected; positive indication of the direction of frequency deviation; panel terminals for the audio output and for the output of the crystal buffer stage for calibrating or adjusting transmitters or receivers.

You'll find that this combination of instruments is one of the best G-R has developed for high-frequency communications monitoring.

Because we are in full-time production of war orders, none of these instruments are available for shipment, and probably will not be until after the war. We ARE accepting reservation orders, however, and will fill them in rotation as soon as production starts.

FREQUENCY METER

RANGE: 0 to 60,000 cycles in six ranges

ACCURACY: ±2% of full scale

INPUT VOLTAGE: Any between 0.25 and 150 volts

MOUNTING: Relay-rack panel; walnut end-frames (illustrated) for table mounting, extra

TYPE 1176-A FREQUENCY METER **$185.00**

●

FREQUENCY MONITOR

CARRIER RANGE: 1500 kc to 200 Mc

ACCURACY: 0.003% with our quartz plates

QUARTZ PLATES: Up to four, not included in price; ground to channel frequency

MOUNTING: Same as Frequency Meter

TYPE 1175-A FREQUENCY MONITOR **$250.00**

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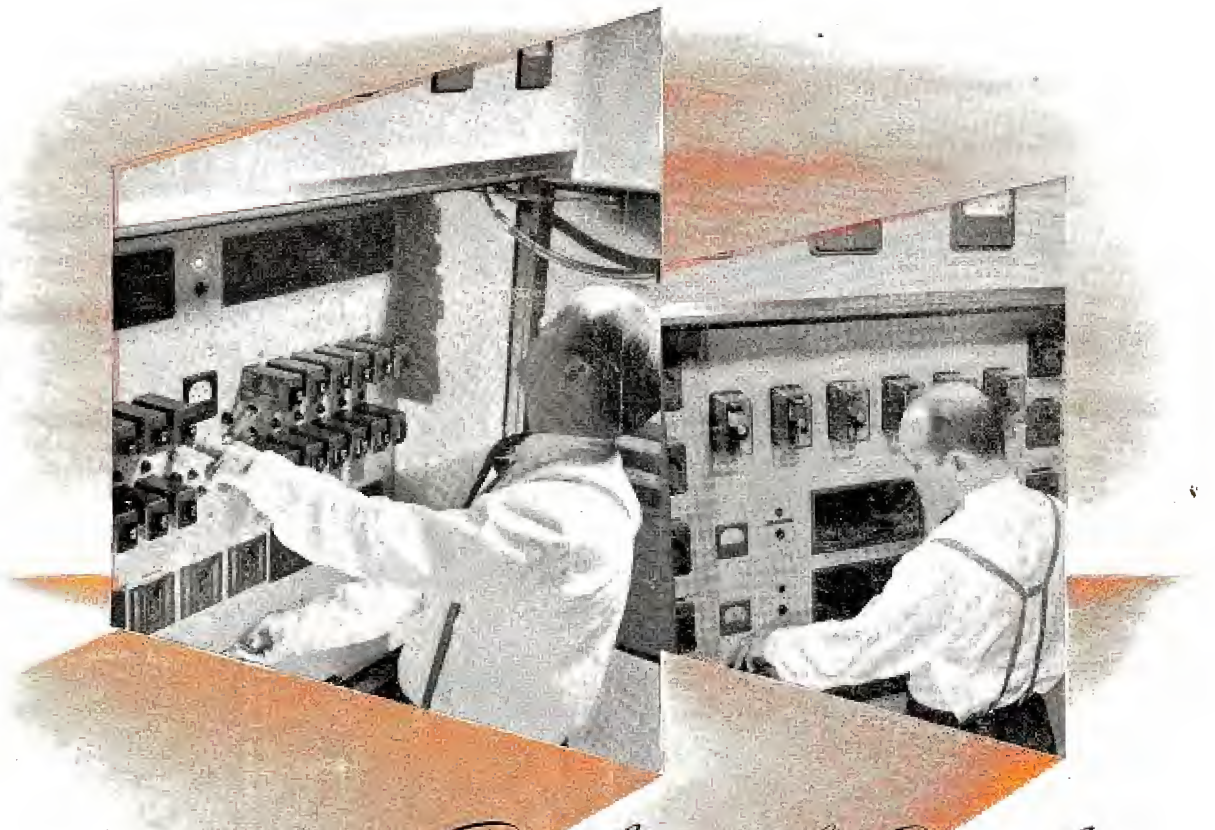

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1. One Master Control puts the transmitter on the air and cuts the power off at the end of the broadcast period. It is impossible for power to be applied in the wrong sequence.
2. Individual Tuning and Adjustment Controls are mounted on the front panel, easily accessible.
3. Indicator Lights Flash Circuit Conditions to Operator, indicating instantly which circuit requires attention.
4. Simplified Circuits—require a minimum of tubes . . . no tricky wiring.
5. "De-ion" Breakers Show Outage Location, providing fuseless protection for the low-voltage power circuits.

Simplicity of Control is only one feature of Westinghouse Transmitters. Others equally important are: ***Low Operating Cost, Continuity of Operation, High Fidelity Signals, Ease of Maintenance.***

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